Do all people, irrespective of their language and cultural background perceive and talk about landscapes in the same way? Or are there differences in how we carve out and name identifiable units of the continuous surface of the Earth? If there are differences, what does this mean for representing our environment in Geographic Information Systems (GIS)? This thesis explores these questions through ethnographic work in the Bolivian Amazon rainforest.

The first part of this thesis explores folk landscape categorisations, focusing on uses and cultural importance of landscape features. Such folk categorisations have hitherto not been represented on maps or in GIS used by local authorities. The second part investigates how such local understandings can be better represented on maps and in a GIS.

The findings of this thesis highlight that differences in landscape categorisation can have important practical implications. How an area is categorised and represented on maps and in GIS influences decisions regarding natural resource management, often with tangible consequences for indigenous peoples.

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Flurina Wartmann From Space to Place in the Bolivian Amazon

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From Space to Place in the Bolivian Amazon –

Exploring and Representing Folk Landscape Categories with Ethnographic and GIS Approaches

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Exploring and Representing
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with Ethnographic and GIS Approaches**

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Summary

How do people perceive landscapes? Do all people, irrespective of their language or culture perceive landscapes in the same way, or are there differences in how people identify and name landscape features? If there are linguistic and cultural differences in landscape conceptualisation, what does this mean for how we represent our environment in Geographic Information Systems (GIS)? This thesis explores these questions through a case study in the Amazon rainforest in Bolivia where an indigenous territory and a protected area overlap.

Using a range of ethnographic methods, such as participatory observation, field walks, and interviews with local consultants I explored folk landscape categorisations in the Spanish dialect spoken in the study area. As well as documenting landscape terms, I also investigated the cultural importance and local uses of the identified landscape units, and paid attention to their ecological underpinnings. The elicited folk landscape categorisation consists of 156 categories, of which 60 refer to vegetation units, followed by categories for agricultural areas (30), water-related features (27), topographic features (25), areas characterised by substrate (13) and one folk landscape category characterised by the inhabitance of an animal species. Most of the folk vegetation categories are identified and named according to visually salient indicator plants or plants with specific local uses. For example, the vegetation stand called *jatatal* is characterised by dense stands of *jatata* plants (*Geonoma deversa*). The *jatata* plant is used to construct traditional roof thatching and is of high economic importance, as thatched *jatata* roofs are sold on local markets. Customary management of a *jatatal* includes access regulations mediated through family or community membership and traditional harvesting practices that allow the continued use of a *jatatal*. Another example is the folk category *salitral*, which refers to an area with mineral salt licks where different animal species come to nibble at the substrate. *Salitrales* are culturally important landscape units for hunters and are believed to be inhabited by spirits. Consequentially, certain behavioural rules have to be followed at a *salitral*.

Comparing folk vegetation categories with a scientific botanical classification of the area, similarities, but also conceptual differences came to the fore. Common to both systems is the use of visually salient or easily reconisable species as indicator plants. For instance, the folk vegetation *charral* is identified by the *charo* plant (*Gynerium sagittatum*), which is also an indicator species in the botanical classification of 'Pioneer riverine reed area of *Gynerium sagittatum* on sandy soils'. However, while folk landscape categories reflect utility, visual saliency and cultural importance, the scientific classification differentiates vegetation units based on their edaphic regime and sometimes indicator species, without taking into account local use or significance.

In addition folk landscape categories in the local Spanish dialect, I also explored landscape categorisation in the two indigenous languages spoken in the study area. Landscape categories in Takana and Mosetén do not always neatly match on the Spanish landscape terms and their meanings. Some terms and their related concepts are specific to one language and not easily translatable. Such variations in landscape categorisations are not only local curiosities, but have important implications for how environments are represented on maps and in GIS, and for how they are being managed. Because current maps are based on scientific landscape classifications, local views are commonly neglected during decision-making processes. The GIS used in the protected area and in the indigenous territory, for instance, did not contain locally used categories such as culturally important use areas, despite their importance for how people used such areas. There is thus a need to find ways in which to represent folk landscape categories on maps and in a computational environment.

Therefore, I used sketch mapping exercises with local consultants to explore which features consultants chose to represent on a hand-drawn map. Consultants drew few features on maps compared to the vocabulary of folk landscape categories elicited through the ethnographic methods. This highlights the challenge of participatory mapping initiatives, which, by focusing on spatial representations, will only document certain aspects of local spatial and environmental knowledge compared to the overall landscape vocabulary people use in direct speech.

To represent the ethnographically elicited folk categories in a computational environment, I conducted a simple usability study with the open-source webmapping platform 'Cartaro'. Consultants found Cartaro easier to use than the GIS and appreciated the possibility to add texts and images to geographic data. However, during usability testing, consultants added only very few categories, such as rivers and settlements, which underscores the importance of combining different methodological approaches for documenting and representing local understandings and uses of landscapes.

This thesis combined ethnographic and linguistic approaches to explore local landscape categories and ways in which to represent them on maps and in a computational environment. Importantly, the documented folk landscape categories are more than 'just categories'. Categories and their associated meanings influence the way in which people interact with them. If indigenous peoples are to be empowered in their interactions with government authorities in managing landscapes, there is a need to consider how to better represent their uses and understandings of landscape. Otherwise, indigenous peoples are forced to rely on information systems based on Western scientific ontologies. Within GIScience, finding ways to integrate different forms of knowledge is thus an important step towards allowing the use and exchange of geographic information across different groups of people who may conceptualise the world in different ways.

Zusammenfassung

Wie nehmen Menschen Landschaften wahr? Nehmen alle Menschen, ungeachtet ihrer Sprache und Kultur Landschaften gleich wahr? Oder gibt es Unterschiede, wie Menschen Landschaftselemente identifizieren und benennen? Falls es solche linguistischen und kulturellen Unterschiede in der Konzeptionalisierung von Landschaft gibt, was bedeutet das für die Umgebung in Geographischen Informationssystemen (GIS)? Die vorliegende Arbeit untersucht diese Fragen anhand einer Fallstudie im Amazonasregenwald in Bolivien, in einem Gebiet, in dem ein indigenes Territorium mit einem staatlichen Schutzgebiet überlappt.
Mittels einer Reihe ethnographischer Methoden, wie partizipative Beobachtung, Feldbegehungen und Interviews mit lokalen Personen als Beratende, untersuchte ich lokale Landschaftsbegriffe oder sogenannte Volkskategorien im spanischen Dialekt, welcher im Studiengebiet von der indigenen Takana Bevölkerung gesprochen wird. Zusätzlich zur Dokumentation der lokalen Landschaftsbegriffe untersuchte ich zudem die kulturelle Bedeutung und den lokalen Nutzen der genannten Landschaftseinheiten, sowie deren ökologische Grundlagen. Die dokumentierten Volkskategorien für Landschaftselemente umfassten 156 Begriffe, wovon sich 60 auf Vegetationseinheiten bezogen, 30 auf landwirtschaftlich genutzte Flächen, 27 auf hydrologische Elemente, 25 auf topographische Elemente, 13 auf Gebiete, die durch ein Substrat charakterisiert waren, sowie eine Kategorie für ein Gebiet, welches durch die Nutzung einer Tierart definiert wird. Der Grossteil der Volkskategorien für Vegetationseinheiten wurde durch visuell hervorstehende Indikatorpflanzen oder durch Pflanzen mit einer lokalen Nutzung identifiziert und benannt. Zum Beispiel zeichnet sich die Vegetationseinheit *jatatal* durch eine Ansammlung an *jatata* Pflanzen aus (*Geonoma deversa*, eine Palmenart). Die Takana verwenden die *jatata*-Palme, um traditionelle Dachbedeckungen herzustellen und auf lokalen Märkten zu verkaufen. Der Zugang zu einem *jatatal* und dessen Nutzung ist durch kulturelle Normen und Regeln definiert, welche auf der Zugehörigkeit zu einer Familie oder Dorfgemeinde beruhen und bestimmte nachhaltige Techniken zur Ressourcennutzung der *jatata*-Palme beinhalten. Ein weiteres Beispiel ist die Volkskategorie *salitral*, welche ein Gebiet mit einer Salzleckstelle bezeichnet, wo verschiedene Tierarten das mineralhaltige Substrat abknabbern. *Salitrales* sind kulturell wichtige Landschaftseinheiten für Jäger und werden gemäss den Takana von Geistern bewohnt, weshalb in der Nähe eines *salitral* gewisse Verhaltensregeln befolgt werden müssen.

Ein Vergleich der Volks-Vegetationseinheiten im Spanischen mit einer wissenschaftlichen, botanischen Klassifikation des Untersuchungsgebietes in Spanisch zeigte gewisse Ähnlichkeiten, wie auch Unterschiede zwischen den beiden Kategorisierungen. Beiden Systemen gemeinsam war die Verwendung von visuell hervorstechenden oder leicht zu identifizierenden Pflanzen als Indikatorarten. Die Volkskategorie *charral* beispielsweise wurde durch die *charo* Pflanze (*Gynerium sagittatum*, eine Süssgrasart) identifiziert, welches auch eine Indikatorart war in der botanischen Klassifikation für die Vegetationseinheit ‚Flussbegleitender Pionierpflanzengürtel aus *Gynerium sagitattum* auf sandigen Böden‘. Während allerdings die Volkskategorien oft den praktischen Nutzen und die kulturelle Bedeutung einer Landschaftseinheit für die lokale Bevölkerung widerspiegeln, basiert die wissenschaftliche botanische Klassifikation hingegen auf dem edaphischen Regime eines Gebietes und beinhaltet nur teilweise eine Zeigerpflanze. Sie nimmt zudem keinen Bezug auf lokale Nutzung oder Bedeutung von Landschaftseinheiten.
Zusätzlich zu Begriffen im lokalen spanischen Dialekt untersuchte ich Landschaftskategorien in den zwei indigenen Sprachen Takana und Mosetén. Die Kategorien für Landschaftseinheiten in Takana und Mosetén hatten nicht immer eine Entsprechung im

spanischen Dialekt. Gewisse Begriffe und die dazugehörigen Konzepte waren sprachspezifisch und deshalb schwierig zu übersetzen. Solche Unterschiede zwischen Sprachen sind nicht bloss sprachliche Kuriositäten, sondern haben wichtige Auswirkungen, wie Landschaften beschrieben und auf Karten und in einem GIS dargestellt werden. Diese Darstellungen wiederum beeinflussen die Verwaltung dieser Landschaften. Da gängige Karten auf einer wissenschaftlichen Landschaftsklassifikation beruhen, werden in Entscheidungsprozessen lokale Ansichten häufig vernachlässigt oder übergangen. Das GIS, welches von den Verwaltungen des Schutzgebiets und des indigenen Territoriums genutzt wurde, beinhaltete zum Beispiel keine Volkskategorien, wie beispielsweise kulturell wichtige oder genutzte Gebiete innerhalb des Regenwaldes, obwohl solche Gebiete für die lokale Bevölkerung von grosser Bedeutung waren. Deshalb ist es nötig, Wege zu finden, um Volkskategorien auf Karten und in GIS darzustellen.

Um zu erforschen, welche Elemente der Landschaft für die Darstellung auszuwählen sind, führte ich mit indigenen Beratern Skizzenkartierungen durch, in denen sie frei von Hand gezeichnete Skizzen ihrer Umgebung erstellten. Verglichen mit der Anzahl umgangssprachlicher Volkskategorien, die ich mittels ethnographischer Methoden dokumentiert hatte, zeichneten indigene Beraterinnen und Berater allerdings nur wenige Landschaftselemente auf den Skizzenkarten ein. Dies zeigt eindrücklich die Herausforderung, mit welchen sich partizipative Kartierungsprojekte konfrontiert sehen. Karten, die aus solchen Projekten hervorgehen, zeigen durch den Fokus auf die räumliche Darstellung nur gewisse Aspekte des lokalen raumbezogenen Wissens zu Landschaft.

Um Volkskategorien zu Landschaft und das damit verbundene lokale Wissen in einer digitalen Umgebung darzustellen, führte ich ausserdem eine kleine Nutzerstudie mit der Webkartierungsplattform ‚Cartaro' durch. Die Teilnehmerinnen und Teilnehmer fanden ‚Cartaro' einfacher zu verwenden als ein GIS, und schätzten die Möglichkeit, Text und Bilder zur geografischen Daten hinzuzufügen. Allerdings verwendeten die Teilnehmenden nur wenige Kategorien zur Kartierung in Cartaro, wie zum Beispiel Flüsse und Siedlungen. Dies zeigt wiederum auf, wie wichtig es ist, verschiedene methodische Ansätze zu kombinieren, um lokales Wissen und Nutzung der Landschaft zu dokumentieren und darzustellen.

Diese Arbeit verwendete linguistische und ethnographische Ansätze, um Volks-Landschaftskategorien und Möglichkeiten, wie diese auf Karten und in einem GIS dargestellt werden können, zu untersuchen. Eine wichtige Erkenntnis aus der Arbeit ist, dass die dokumentierten Volkskategorien für Landschaft mehr sind als „nur" Kategorien. Denn Kategorien und die damit verbundenen Bedeutungen beeinflussen, wie wir mit den realen Objekten, auf welche diese Kategorien Bezug nehmen, umgehen. Falls indigene Gruppen unterstützt werden sollen, mit Regierungsbehörden zu interagieren, wenn es darum geht, Gebiete zu verwalten, wird es nötig, die lokale Nutzung der Landschaft und die damit verbundenen kulturellen Bedeutungen besser darstellen zu können. Ansonsten wird die Lokalbevölkerung gezwungen sein, Informationssysteme zu verwenden, welche auf westlichen, wissenschaftlichen Ontologien beruhen, die nicht ihrer Wahrnehmung entsprechen.

Diese Arbeit zeigte mögliche Wege auf, wie unterschiedliche Formen von Wissen integriert werden können. Dies ist ein wichtiger Schritt auf dem Weg zur Erreichung eines zentralen Ziels des Forschungsgebietes der GIScience, nämlich, die Nutzung und den Austausch geographischer Information zwischen verschiedenen Gruppen und Institutionen zu ermöglichen, welche die Welt unterschiedlich wahrnehmen mögen.

Resumen

¿Cómo perciben las personas los paisajes? ¿Los perciben de la misma manera independiente de su idioma o cultura, o hay diferencias en cómo identifican y nombran los rasgos del paisaje? ¿Si existen diferencias lingüísticas y culturales en la conceptualización del paisaje, que tan importantes son estas en el momento de representar nuestro medioambiente en los Sistemas de Información Geográficos (SIG)?

La presente tesis explora estas preguntas a través de un caso de estudio en la selva tropical del Amazonas boliviano en el cual coinciden un territorio indígena y un área protegida.

Usando una variedad de métodos etnográficos, como la observación participativa, caminatas de campo, y entrevistas con consultores locales, exploré las categorizaciones autóctonas del paisaje en el dialecto español hablado en el área de estudio. Así como, la documentación de los términos del paisaje, también investigué la importancia cultural y los usos locales de las unidades del paisaje identificadas, prestando atención a su fundamento ecológico. Las categorizaciones del paisaje obtenidas consistieron en 156 categorías, de las cuales, 60 se refieren a unidades de vegetación, seguidas por las categorías para áreas agrícolas (30), características hídricas (27), y topográficas (25), áreas caracterizadas por el sustrato (13) y una categoría caracterizada por ser el habitad de una especie de animal. La mayoría de las categorías autóctonas de vegetación fueron identificadas y nombradas de acuerdo a plantas indicadoras visualmente notables o por aquellas con usos locales específicos. Por ejemplo, la categoría de vegetación llamada *jatatal* se caracteriza por áreas densas de plantas de *jatata* (*Geonoma deversa*). El manejo de un *jatatal* incluye medidas de acceso reguladas a través de relaciones familiares o comunitarias y prácticas de cosecha tradicionales que permiten el continuo uso de un *jatatal*. Otro ejemplo de categoría autóctona es el *salitral*, que hace referencia a un área dónde las diferentes especies de

animales vienen a mordisquear el sustrato. Los *salitrales* son unidades del paisaje culturalmente importantes para los cazadores y se cree que son habitados por espíritus. Por ende, ciertas reglas de comportamiento tienen que ser seguidas en un *salitral*.

Comparando las categorías locales de vegetación con clasificaciones botánicas científicas del área, se hacen evidentes las similitudes pero también las diferencias conceptuales. Común a ambos sistemas era el uso de plantas visualmente salientes o especies fácilmente reconocibles como plantas indicadoras. Por ejemplo, la vegetación autóctona identificada por la planta *charo* (*Gynerium sagittatum*) también era una especie indicadora en la clasificación botánica de 'Área rivereña de *Gynerium sagittatum* en tierras arenosas'. Sin embargo, mientras las categorías autóctonas del paisaje reflejaron utilidad, importancia visual y cultural, la clasificación científica diferenció las unidades de vegetación basadas en su régimen edáfico y a veces en las especies indicadoras, sin tener en cuenta el uso local o importancia de las mismas.

Además de las categorías de paisaje autóctonas en el dialecto español local, exploré la categorización del paisaje en los dos idiomas indígenas Takana y Mosetén hablados en el área del estudio. Las categorías del paisaje en Takana y Mosetén no siempre concuerdan pulcramente con las categorías del paisaje en español y sus significados. Algunos términos y sus conceptos relacionados eran específicos a un idioma y no fácilmente traducibles. Tales variaciones en las categorizaciones del paisaje no sólo son curiosidades locales, pero tienen importantes implicaciones para cómo se representan los ambientes en los mapas, en los SIG, y en cómo son gestionados. Ya que los mapas actuales están basado en las clasificaciones del paisaje científicas, normalmente las perspectivas locales son abandonadas durante los procesos de toma de decisiones. Por ejemplo, los SIG usado en el área protegido y en el territorio indígena no contuvieron ningunas categorías localmente usadas tales como áreas de uso culturalmente importantes, a pesar de su importancia en cómo las

personas usaban las tales áreas. De este modo existe la necesidad de encontrar la manera de representar las categorías autóctonos del paisaje en los mapas y los SIG.

Por consiguiente, usé ejercicios de esquemas cartográficos para explorar que características escogieron los consultores locales para representar en un mapa hecho a mano. Los consultores dibujaron pocas características en mapas en comparación al vocabulario de categorías del paisaje autóctonos sacados a través de los métodos etnográficos. Esto resalta el desafío de iniciativas participativas de mapeo que, enfocadas en las representaciones espaciales, documentarán sólo ciertos aspectos de conocimiento espacial y medioambiental local comparados al vocabulario general usado por las personas al comunicarse con sus pares.

Para representar etnográficamente las categorías autóctonas obtenidas en un ambiente computacional, dirigí un simple estudio de utilidad con 'Cartaro', una plataforma de mapeo web libre. Los consultores encontraron a Cartaro más fácil para usar que otros SIG y apreciaron la posibilidad de agregar textos e imágenes a los datos geográficos. Sin embargo, durante la prueba de utilidad, los consultores agregaron muy pocas categorías, como ríos y asentamientos, que resalta la importancia de combinar las metodologías diferentes para documentar y representar las comprensiones locales y usos de paisajes.

Por lo tanto esta tesis combinó métodos etnográficos y lingüísticos para explorar categorías locales del paisaje y maneras en como representarlos en los mapas y en un ambiente computacional. Más importante aún, las categorías autóctonas del paisaje documentadas son más que 'sólo categorías'. Las categorías y sus significados asociados influyen en la manera en que las personas interactúan recíprocamente con ellos. Si queremos fortalecer la posición de los pueblos indígenas en sus interacciones con las autoridades gubernamentales en la gestión de paisajes, hay una necesidad de considerar cómo representar mejor sus usos y comprensiones de los mismos. De otra forma, los indígenas serán

obligados a confiar en los sistemas de información basados en las ontologías científicas Occidentales.

Para el área de la investigación de las Ciencias de Información Geográfica, encontrar formas de integrar los diferentes tipos de conocimiento es un paso importante hacia la meta de desarollar SIG que permitan el uso e intercambio de información entre diferentes grupos de personas que conceptualizan el mundo de maneras diferentes.

The world is so empty if one thinks only of mountains, rivers and cities; but to know someone who thinks and feels with us, and who, though distant, is close to us in spirit, this makes the earth for us an inhabited garden.

Johann Wolfgang von Goethe,
'Wilhelm Meisters Lehrjahre', in:
Goethes Sämmtliche Werke, vol. 7 1874: 520

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List of Abbreviations

ANMI	Área Natural de Manejo Integrado (Spanish for Natural Area of Integrated Management)
API	Application Programming Interface
CIPTA	Consejo Indígena del Pueblo Takana (Spanish for Indigenous Council of the Takana People)
CMS	Content Management System
CORINE	Coordination of Information on the Environment
CRTM	Consejo Regional Tsimané Mosetén (Spanish for Regional Council of Tsimané and Mosetén People)
ELU	Global Ecological Land Units
ESRI	Environmental Systems Research Institute Inc.
GIS	Geographic Information System
GIScience	Geographic Information Science
GML	Geography Markup Language
GPS	Global Positioning System
JPEG	File format developed by the Joint Photographic Experts Group
LANMAP	European Landscape Classification
NGO	Non-Governmental Organisation
OGC	Open Geospatial Consortium
PGIS	Participatory GIS
PN	Parque Nacional
PNG	Portable Network Graphic
SERNAP	Servicio Nacional de Áreas Protegidas (National Service for Protected Areas)
TCO	Territorio Comunitario de Origen (Spanish for Indigenous Territory)
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WCS	Wildlife Conservation Society
WFS	Web Map Service Interface Standard
WFS-T	Web Feature Service
XML	Extensible Markup Language

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The perceived world is the always presupposed foundation of all rationality, all value, and all existence.

Maurice Merleau-Ponty (1963) in: *The Primacy of Perception,* p. 13

Chapter 1
Introduction

How do people perceive the world around them? Do all people, irrespective of their culture, language and background perceive their environment in the same way, or are there differences in how people carve up their surroundings into identifiable, shared categories (Mark, Turk, and Stea 2007)? And if yes, what does this mean for how we represent the world on maps and in Geographic Information Systems (GIS) (Mark et al. 2011a; Robbins 2001; Wellen and Sieber 2013)?

These questions are important, because geographic categories in the form of land use, land cover or landscape categorisations have become crucial both for research and policy, for example in monitoring landscape change (Kienast et al. 2015), as well as modeling patterns and processes (Feranec et al. 2010; Price et al. 2015). A typical example is the Global Ecological Land Units (ELU) classification developed jointly by the US Geological Survey (USGS) and ESRI that divides the global land surface into squares of 250m containing information on landform, climate and surface rock type, which in turn influence land cover (ESRI 2015). The claim is that:

With the Global ELU map and the data behind it, scientists, planners, conservationists, and the public can access information about the environment using a common framework, a common language, and a common spatial unit.

(ESRI 2015)

The goal of the ELU classification to improve communication between scientists and the public is in line with calls for more participation in landscape policy. The European Landscape Classification, for instance, emphasises the importance of participation of the general public, local and regional authorities and other interested parties in landscape management and planning, underlining that views of different groups should be included, not just those of an academic or political elite (Jones 2007). However, despite these commendable goals, typical landscape classifications such as Ecological Land Units, the European Landscape Classification (LANMAP) (Mücher et al. 2010), and CORINE land cover classes of the European Environmental Agency (Feranec et al. 2010) are based on bio-physical properties of the landscape. The categories and their definitions are made by experts and often difficult to understand for the public. For instance, although the Ecological Land Units categories should provide a 'common framework and a common language', examples of categories include 'warm dry hills on metamorphic rock with sparse vegetation' or 'cool moist plains on carbonate sedimentary rock with mostly deciduous forest'. Such categories are far removed from everyday terms used by a broader public, inhibiting the involvement of the public in discussions and decision-making. This is problematic, because a landscape policy devised only by experts and administrators will result in landscapes imposed on the public (Prieur et al. 2006). This relatively new view includes the notion of power that is imbued in the process of categorisation (Bourdieu and Thompson 1991), illustrating that categories are more than terms that refer to underlying referents, but that they have materialitity in the sense that they mediate people's interactions with their environment (Bowker and Star 2000; Braun 2000).

In GIScience and physical geography, however, the basic assumption for long has been that geographic categories (and their spatial representations) are objective, value-neutral and apolitical, and that categories such as *forest* and *river* are universal, carved out of the landscape along natural discontinuities (Foody 2002; Mücher et al. 2010; Tagil and Jenness 2008). If we assume such concepts are indeed universal, it follows that they are easily translatable across languages. We can think of an example with the seemingly straightforward category *forest*. After all, is it not the case that a forest is always a forest, whether you call it *forêt* (French), *Wald* (German), *bosque* (Spanish), *лес* (Russian) or *hutan* (Indonesian)?

More recently, linguists, anthropologists, geographers and ethnoecologists found that there is a large cross-cultural and cross-linguistic variation in geographic categorisation (Burenhult and Levinson 2008; Johnson and Hunn 2010a). There are few, if any, universal geographic categories, and often, the terms for geographic categories do not neatly match between languages and cultures (Bromhead 2011; Mark and Turk 2003a; Smith and Mark 2003; Johnson 2011). For example, the semantics associated with the terms *forêt* and *hutan* may not be the same as for the English *forest*.

Even within the same language, the same term can be understood differently, depending on the context. An illustrative example is the land cover classification system 'CORINE' of the European Union (Feranec et al. 2010), where even the previously mentioned and seemingly simple concept as 'forest' causes problems, because:

'[…] while in Britain, according to Forest Enterprises a 'forest' might not even have any trees on it, and, in both Scandinavia and Eire, land covered in slow-growing trees might not be forest at all'

(Comber et al. 2005, p. 200)

One might argue that such differences between people from different backgrounds and cultures, or between people speaking different languages, are little more than local curiosities. However, depending on the definition of the category of 'forest', different institutions and countries will designate different areas as 'forest', which has tangible consequences for the monitoring of landscape change, as well as for managment. As Robbins (2001) elaborately shows in an ethnographic study in the Indian state of Rajasthan, the landscape category 'forest' of professional foresters diverges from the 'junglat' category of local people. For example, local people do not include areas of invasive shrub covers in their definition of 'junglat', while foresters include these areas in land cover maps as 'forest'. Because only the latter categorisation is used for mapping land-cover categories, invasive shrub covers are re-cast as 'forest' and are managed accordingly in a process of 'reverse adaptation' (Robbins 2001), in which the actual landscape is managed according to the way it was categorised by scientists and resource managers.

This example illustrates how categories and their associated meanings are a crucial part of how knowledge systems are constituted (Lakoff 1987; Rosch 1978; Tversky and Hemenway 1984). Categories also form the basis for representations in formal environments such as GIS (Kuhn 2001; Schuurman 2006). Commonsense geographic categorisations are thus at the very core of GIScience, because the translation of natural language concepts and categories into formal environments of information systems is non-trivial, and complicated by the fact that different terms can be used for the same phenomenon, or, the same terms can be used in a different manner, depending on the context (Schuurman 2006).

From a GIScience perspective, with few exceptions (e.g. Wellen and Sieber 2013), there has so far been relatively little research about how geographic categorisations documented in ethnographic and linguistic work (e.g. Johnson and Hunn 2010b; Mark

et al. 2011a) can be used as a basis to develop representations in GIS. Given the importance of maps and GIS in landscape management and spatial planning, there is a need to examine geographic categorisations of the broader public, in order to eventually place such categorisations on a more equal footing with more authoritative, scientific landscape categorisations.
This research gap provided the starting point for this PhD thesis, which was guided by the following overarching research question:

- **How can local landscape categorisations be accessed and represented?**

The overall goal of this thesis was to investigate folk landscape categorisations and how they can be better represented on maps and in GIS. Based on a literature review presented in detail in Chapter 2, I identified the following specific research questions that this thesis aimed to address through a case study:

- *RQ1: What is the current institutional setting for landscape management?*
- *RQ2: What categories are culturally recognised in a landscape folk categorisation and what are their ecological underpinnings and cultural importance?*
- *RQ3: How is a folk categorisation of landscape organised and what are drivers for landscape categorisation?*
- *RQ4: How does the categorisation of the same landscape differ between different groups of people?*
- *RQ5: How can local understandings of landscape be represented on maps and in a computational environment?*

1.1. Structure of the thesis

Based on the overarching and the specific research questions, the rest of the thesis is structured as follows:

Chapter 2 introduces the theoretical background structured around the three main themes, which are categorisation (§ 2.1), landscape (§ 2.2), and geographic knowledge production through GIS (§2.3). Based on this literature review, I identified research gaps and devised a set of detailed research questions to explore these gaps (§ 2.4). **Chapter 3** expounds the results for RQ1, introducing the socio-cultural context and the institutional setting for landscape management in the study site in the Bolivian Amazon from a historical perspective. **Chapter 4** describes the methodological approaches used to elicit and represent folk landscape categorisations in the study area. **Chapter 5** presents local terms for landscape units in the local Spanish dialect, including their ecological underpinnings, and cultural significance (RQ2). In **Chapter 6**, the principles for the organisation of the Spanish folk categorisation are analysed and different drivers for this categorisation investigated (RQ3). **Chapter 7** presents the results for RQ4 on folk landscape categorisations in Takana and Mosetén, comparing the landscape categorisation in these two indigenous languages with the folk landscape categories in Spanish. Furthermore, in **Chapter 7**, the folk categorisations of vegetation units are compared with an existing scientific botanical classification (RQ4). **Chapter 8** presents ways in which these folk categories can be linked to spatial representations on hand-drawn sketch maps and in a computational mapping interface (RQ5). In the discussion in **Chapter 9** I recall the findings with respect to the research questions and relate them to existing literature. **Chapter 10** sums up the contributions of the thesis to the overall research questions, highlights possible implications, and outlines further work.

Reading furnishes the mind only
with materials of knowledge;
it is thinking that makes
what we read ours.

Attributed to John Locke

Chapter 2 Background

This chapter presents the relevant background for the overarching research question of this thesis:

- **How can local landscape categorisations be accessed and represented?**

From this question, three major topics of relevance are identified and introduced in this chapter.
Firstly, ***categorisation*** is an important topic for this thesis, because categorisation research investigates how people make sense of the world around them by subdividing it into categories at different levels. Categorisation is a major research area in psychology, with associated methods that have also been adopted within GIScience.
Secondly, ***landscape*** is a central concept in this thesis, because this thesis focuses on how how the domain of landscape is categorised into meaningful identifiable units. The concept of landscape is used in different research areas including geography and anthropology, with understandings varying between these fields. For my thesis, the ecological aspects are less relevant, as the focus is on the human perception of and interaction with landscape, with the related literature in landscape ethnoecology.

Thirdly, the question of how geographic knowledge is produced on maps and in **Geograhic Information Systems** (GIS) is addressed in the research area of Geographic Information Science (GIScience).
After presenting the background for each of these research areas, I identify research gaps, and, based on those, derive the specific research questions that guided this thesis.

2.1 Categorisation[1]

One of the aims of studying categories is understanding how people make sense of the world around them by subdividing it into categories at different levels of abstraction (Lakoff 1987; Tversky and Hemenway 1983). Categorisation has been a subject of study in various research fields ranging from anthropology (Berlin 1992; Berlin and Kay 1969; Hunn 1975), linguistics (Shatford 1986; Taylor 2003), and psychology (Lakoff 1987; Rosch and Lloyd 1978), to geography (Mark, Smith, and Tversky 1999), and information science (Bowker and Star 2000). But what are categories and their characteristics, and how can we investigate them? Mervis and Rosch defined a category as follows:

A category exists whenever two or more distinguishable objects or events are treated equivalently.
(Mervis and Rosch 1981, p. 89)

This equivalent treatment includes, for instance, labelling objects or events with the same name, or, performing the same action on different objects (Mervis and Rosch 1981). Cognitive psychologists have investigated various questions related to categories, some of which are highly relevant to this thesis, such as:

- How are categories organised into hierarchical levels?

[1] The content of this subchapter is based on the introduction of the publication by Wartmann et al. 2015.

· What drives category organisation?
· Are members of categories equal members or are some members more typical than others?

Much of the work in psychology focused on the categorisation of domain areas such as furniture (Rosch 1978), where the objects for categorisation are typically small, moveable and often manmade. The geographic domain may thus be particularly interesting for the study of categorisation, because it exhibits several particularities that set it apart from other semantic domains. Rather than crisp physical boundaries such as the 'bona fide' boundary between a *cat* and a *carpet*, for instance (Smith and Mark 2003), the Earth's surface is a continuum and it is often unclear where a *valley* ends and a *hill* begins. This gives rise to 'fiat' boundaries for geographic features that are 'induced through human demarcation' (Smith and Varzi 1997). It is important to notice that this distinction between table-top space objects and geographic features and the nature of their boundaries is based on human perception. For an organism such as a flea, a cat may present itself as a large region with *fiat* boundaries, because for a flea, it might not be so clear where the cat ends and the carpet begins.
Another particularity of geographic features such as *mountains* or *valleys* is that they are the result of morphogenesis rather than the products of evolution such as birds or mammals, as Smith and Mark argue:

> the category *mountain* is not distinguished in *bona fide* fashion from neighboring categories such as *hill, ridge, butte, plateau, plain,* and so on. The kind *mountain* is not a product of natural selection, nor does it represent an artifactual kind with *bona fide* instances which have arisen as a reflection of special human intention or purpose.
> (Smith and Mark 2003, p. 412, emphasis in original)

However, although the physical reality of mountains arises from geological processes, the concept of a 'mountain' is still very much a reflection of human deliberation, which is evidenced by the differences in what physical features are considered a 'hill' or a 'mountain' by people from different cultural backgrounds. For instance, many Swiss people would probably not consider most British mountains to be mountains at all. In that respect, geographic categories (e.g. 'hill' and 'mountain') behave similar to other domains where different adjoining concepts also have fuzzy semantic boundaries between categories, such as the distinction between 'cup' versus 'bowl'.
Geography is thus an interesting domain for categorisation research to study whether the mentioned particularities influence how people categorise geographic features.
In the following paragraphs, the relevant background literature in psychology, cognition and geography on the hierarchical organisation of categories, categorisation drivers and on prototypicality of categories is discussed, with a special focus on work that relates directly to geography.

2.1.1. Hierarchical organisation of categories

Cognitive psychologists are interested in how categories are organised into hierarchies such as *musical instrument* > *guitar* > *classical guitar*, where *musical instrument* was coined the superordinate level, *guitar* the basic level and *classical guitar* the subordinate level, of which the basic level was concluded to be most fundamental and most informative (Rosch 1978). The postulated importance of the basic level arises out of the necessity for cognitive economy, that is, the compromise between the specificity of a category and the number of categories we need to deal with (Rosch 1978; Rosch et al. 1976). The basic level is the level of categorisation that maximises the similarity of members within a category. For example, members of the basic level *guitar*, such as *classical guitar* and *rock guitar* will share many attributes (e.g. having a guitar neck, strings etc.), while at the superordinate level of *musical instrument*, category members such as *guitar, drum* and *flute* will share fewer attributes (e.g. they can be played, they produce sound).

Several experimental approaches were used to determine and characterise the cognitive basic level. For instance, members of basic level categories were identified more quickly compared with members of other category levels and, when asked to give examples, adults first named basic level categories (Rosch et al. 1976). However, this hierarchic organisation of categories is not always so apparent. Whereas the example 'a *rock guitar* is a *guitar* is a *musical instrument*' is fairly straightforward, for geographic categories the issue becomes much more complicated, as it is not clear whether there is such a strict hierarchical organisation in the geographic domain. And even if there was, what are the basic levels? For example, are the categories *river* and *mountain* basic levels? If they are basic level geographic categories, what are the respective subordinate and superordinate categories? For instance, would people consider *stream* a subordinate and *flowing body of water* a superordinate category of *river*? Such questions have not been addressed in geographic studies.

One of the early studies on hierarchies of geographic categories applying Rosch's elicitation methods postulated that categories of administrative units in the United States (e.g. country, state, and city) were basic level geographic categories (Lloyd, Patton, and Cammack 1996). However, the members of categories investigated were not primarily sub-categories, but rather instances such as 'Georgia' for the category 'state'. Tversky and Hemenway (1983) also applied Rosch's elicitation methods to study basic level categories of (outdoor) scenes. In this study *outdoor scene* was considered the superordinate category and *park, city, beach* and *mountain* the basic levels, with, for instance, *lake beach* and *ocean beach* as subordinates of *beach*. Although the investigated

basic level categories also included geographic features such as mountains and beaches, they did not provide a complete taxonomy of the geographic domain, and, similarly to the study by Lloyd et al. (1996), some subordinate categories were instances rather than categories, such as *Sierra Mountains* and *Rocky Mountains* as supposed subordinates for *mountain* (Tversky and Hemenway 1983). In fact, the participants in this study listed instances so often as subordinate categories that the experimenters decided:

[…] we could not rely entirely on our informants since in some cases there was little consensus and idiosyncratic responding (e.g., naming places near their residences).

(Tversky and Hemenway 1983, p. 126)

Rather than questioning whether commonsense categorisations need to exhibit such a strict hierarchical organisation, and, if all hierarchical levels can be applied to the geographic domain, the experimenters then decided, partly according to their 'own intuition', what the subordinate categories had to be (Tversky and Hemenway 1983). Although these experimental settings were supposedly highly controlled and should therefore be comparable between similar experimental settings, the example above shows that results of such studies are to be interpreted critically, because they reflect the researchers' notion of category organisation as much as that of people who participated in the study. However, despite the subjective interpretation of the participants' answers, the study by Tversky and Hemenway (1983) highlighted how geographic categories seem to pose a special problem for hierarchical categorisation. Places such as *Rocky Mountains* can be argued to be an instance as well as a category, which groups some locations together to form a category more like 'all mountains in the Rocky Mountains', which could be considered a subordinate category to *mountain* (Clare Davies, pers. comm.).

Apart from using Rosch's elicitation methods in controlled experimental settings, geographers have investigated classifications of geographic subdomains such as soils and landforms using more ethnographic and field-based methods. For example, Quechua peoples' soil classification in Peru consisted of more than 55 soil categories that one consultant organised in four different levels (Furbee 1989). However, as this hierarchical organisation was based on a sorting exercise with a single consultant, it should be treated with caution, as inter-consultant agreement on organisation of categories cannot be assumed to be equally high as the inter-consultant agreement found in the same study on the naming of categories (Furbee 1989). Another study applying ethnographic methods was conducted with Maninka farmers in Mali on their classification of physical geographic features (Duvall 2008). Substantial ethnographic work including hundreds of observation hours and interviews with 35 participants revealed several higher-level physical geographic folk categories (Duvall 2008). Some of these hierarchical levels were lexicalised, such as *san* (sky) and *dugukolo* (ground). Others were covert categories, which were recognised but not lexically expressed (indicated through square brackets: []), such as [*vegetation*], [*topographic depressions*], [*elevations*], [*water bodies*], [*land cover*], and [*human artefacts*]. For instance, for the covert category [*land cover*], the taxonomically lower level was *dan* (non-anthropogenic landcover), with members such as *konko to* (land cover of hills), and *konko karoma la* (steep slope with gravel and woodland) (Duvall 2008). However, Duvall's study was one of the very few extensive ethnographic works on the organisation of commonsense geographic categories.

This contrasts with fields such as anthropology and biology, where so-called folk hierarchical organisations have been investigated in ethnobiology and ethnozoology. Examples, to name a few, include Berlin's seminal study on the folk taxonomy of plants by the Tzeltal in Mexico (Berlin 1992), studies on folk classification of arthropods by the Kayapó in the Amazon (Posey 1984) and of fish by Galviboa fishermen in Brazil (Paz and Begossi 1996). Berlin coined a folk hierarchical taxonomy of *unique beginner – life-form – intermediate – specific varietal* (Berlin 1992) that links to the idea of a Linnaean hierarchical taxonomic system. In this hierarchy, *plant* would be a *unique beginner*, *tree* a *life-form*, *oak* an *intermediate* and *white oak* a *specific varietal*. However, Berlin's work was criticised for its assumption of rigid hierarchies and the large number of different hierarchies (Selin and Kalland 2003). Empirical work showed that folk hierarchies were often not strict in delineating hierarchical levels, and many folk hierarchies were flatter than expected by Berlin's theory, and did not contain all hierarchical levels (Selin and Kalland 2003).

In empirical studies hierarchical levels are not always easily identified, and there may not be one unifying hierarchical organisation, but different possibilities, because different groups of people may consider different organisational principles and may choose different categories as the basic levels. For example, in an experiment on biological taxonomies using Rosch's elicitation methods, the experimenters and study participants disagreed on what was to be considered a basic level (Rosch et al. 1976). While Rosch and colleagues viewed *bird* as the superordinate category and sparrow as the basic level, their results suggested that for the participants, bird was the basic level and *sparrow* the subordinate level. The basic level is thus not universal, but may depend on individual backgrounds, or level of knowledge of a certain domain (Tanaka and Taylor 1991). Even when controlling for expertise, the hierarchisation of the same domain may vary between people from different cultures. For example, a study compared a folk fish classification between Menominee Indian and US-American majority culture fishers, who all had several decades of fishing experience (Medin et al. 2006). In a free sorting task with labelled cards, all of the majority-culture fishers produced a hierarchy with at least two levels, while four out of sixteen Menominee fishers grouped the fish cards into distinct groups at one level, refusing to produce a hierarchy of groups, even when prompted to do so several times by the experimenters (Medin et al. 2006). However, as the researchers did not investigate further why Menominee fishermen refused to make more hierarchies, it remains unknown whether this refusal was linked to potentially culturally specific ways of knowledge organisation. Hierarchies in folk biological taxonomies may therefore not only reflect expertise, but may be influenced by culture (and language).

Importantly, even though studies may find that people agree on members of categories at different levels, this does not mean they used the same organisation principles or categorisation drivers.

Key messages hierarchical organisation of categories

- Cognitive psychologists identified subordinate, basic and superordinate levels in the hierarchical organisation of categories
- The basic level was postulated to be most informative, as it optimises the specificity of a category versus the number of categories we have to deal with
- What is determined as the basic level may depend on culture, language, and people's expertise in a domain

2.1.2. Categorisation drivers

Folk categorisations of different groups of people were studied for their underlying organisational principles. For example, the folk biological classification of the Kayapó in the Amazon was based on different categorisation drivers at different levels of the hierarchy (Posey 1984). At the superordinate level, the Kayapó distinguished different animals based on utility (e.g. edibility, medicinal value, and ceremonial importance), behavior (e.g. nocturnal, diurnal, flying, and swimming), habitat (e.g. water, forest, and ground-dwelling) and general cultural importance (e.g. social insects as a model organism for Kayapó social organisation).

At the subordinate level, the Kayapó classified, for instance, *mrum* (ants and kin) into covert categories based on the type and location of ant's nests, such as [ants that live in nests above ground] or [ants that live in nests attached to tree trunks] (Posey 1984). Regarding utility, Posey noted that it is not always straightforward to identify utilitarian factors for categorisation, and he postulated that:

Highly differentiated categories recognised by the society as a whole should be the strongest indicator of cultural utility or significance.

(Posey 1984, p. 138)

While there is empirical evidence for cultural importance expressed in high category differentiation, this 'rule' should be viewed critically, because of covert categories that are recognised, but not linguistically expressed (e.g. Duvall 2008).

There is some evidence that apart from utilitarian factors, expertise affects drivers for categorisation. For example, in a study on folk fish classification experts (i.e. sport fishers) sorted cards labeled with common names of ocean fish based on utilitarian and morphological criteria (Boster and Johnson 1989). The sport fishers grouped fish with high value as sports fish and good meat quality together, despite their difference in appearance, while non-experts (undergraduate students with no experience in fishing) used only morphological criteria (Boster and Johnson 1989). Similarly, in a study on folk tree categorisation, landscapers (considered experts) differed in their category organisation from maintenance personnel (considered non-experts). The landscapers used utilitarian considerations, forming groups such as 'desirable trees to plant along city streets', 'flowering ornamental trees' or 'weed trees', whereas non-experts, again, based their groups of trees mainly on morphological similarity (López et al. 1997). Furthermore, for the non-experts there was some evidence that the folk biological or common names also influenced the grouping, because the 'American mountain-ash' ended up in the same group as the 'white ash' and 'green ash' even though in the scientific taxonomy they are only distantly related (López et al. 1997). This sorting behavior thus seems to be largely an artifact of using labelled cards for the sorting task.

Apart from expertise, cultural factors may also play a role in the basis for category organisation. The previously mentioned study comparing Menominee Indian and US-American majority-culture fishermen who all had showed that decades of fishing experience showed that categorisation drivers were different between the two groups (Medin et al. 2006). Majority-culture fishermen provided morphological (62%), utilitarian (32%) and rarely ecological (6%) verbal justifications for their groupings. Menominee fishermen gave more ecological justifications (40%), less taxonomic (33%) and were about as likely as the majority-culture fishermen to give utilitarian justifications (27%) (Medin et al. 2006). The differences in the criteria people use as categorisation drivers may be influenced by the difference in knowledge organisation between cultural groups. In the study by Medin et al. (2006), American majority-culture fishermen primarily used their knowledge on adult fish, while Menominee fishermen based their groups on their knowledge of the entire life cycle of fish, emphasising much more the reciprocal relationships between different fish. Similar influences of cultural background were shown in a study on folk mammal categorisation, in which both US-American undergraduates and Itzaj Mayan consultants in Guatemala sorted 40 cards with written names of local mammals into piles (López et al. 1997). The Itzaj used more morphological and ecological criteria for their sorting, while the American students relied more heavily on size (López et al. 1997). Thus, in folk biological studies, among the criteria identified as categorisation drivers were morphological, ecological, and utilitarian factors.

But how does this translate to how people organise geographic categories?

Furbee's study on Quechua farmers' soil classification (1989) also examined according to which criteria farmers grouped soils. As criteria, the farmers used the soil's material composition (e.g. clay, sand), edaphic regime (e.g. wet, dry), colour, and use for agricultural production (Furbee 1989). Thus, at first glance, the folk organisation of soils seems to be comparable to folk biological classifications according to morphologic, ecological and utilitarian factors.

However, geographic features may represent a special case for categorisation in several ways. Firstly, in the geographic domain, instead of evolutionary processes that led to different organisms with different attributes, morphogenesis leads to different types of landforms. One possibility would therefore be that geographic features are grouped together based on their morphogenesis, for example in a category 'features created by erosion'. In fact, there are examples for such folk categorisations. For instance, Duvall (2008) documented that Maninka farmers recognised the covert category [*features created by animals*], that included *siya* (nest), *nyaga* (lair) and *kome* (salt lick). Secondly, geographic features range in size from small landforms such as pingos to mountain ranges and canyons that often extend beyond our field of view. Size may therefore be a crucial factor in categorisation. Geographic features also have utilities that may affect category organisation, as shown for the utility of soils in agricultural production that influenced category organisation by Quechua farmers (Furbee 1989).

Relatively few studies investigated drivers for folk geographic categorisations. Although it was not a specific focus of Duvall's study (2008), apart from features created by animals from the example above, Maninka farmers seemed to use topography as a categorisation driver, grouping topographic elevations into one group and topographic depressions into another (Duvall 2008).

In a study in Portugal, Williams et al. (2012) explicitly investigated drivers for landform categorisation. Their results indicated multiple drivers for categorisation. On the one hand, salient perceptual features of the landscape seemed to be important, such as shape and profile of landforms, and the presence of water, vegetation, and other land cover. On the other hand, study participants used utilitarian motivations such as land use (Williams, Kuhn, and Painho 2012). In that study, participants always relied on several categorisation drivers, and most often used a combination of land cover/land use and utility to categorise landforms (Williams, Kuhn, and Painho 2012).

Apart from morphogenesis, geographic features are also characterised by part-whole relationships, or so-called 'partonymic' or 'mereological' relationships (Smith 1996). For example, a *hill* has a *slope* and a *crest*, and a *mountain* has a *foot* and a *peak*. In this example, *foot* and *peak* are parts of a *mountain*; they are not members of the category *mountain*. Thus, a taxonomy of the geographic domain would need to include such part-whole relationships. Therefore, Smith proposed a 'mereotopology' of the geographic domain that contains topological as well as mereological aspects (Smith 1996), which, to date has not been tested empirically for folk geographic categories.

Apart from such potential drivers for categorisation, other properties of categories were investigated, for example, why some members are more typical examples of a category than others, which I address in the next section.

Key messages categorisation drivers

- Empirical studies showed that folk categorisation drivers can be morphological, ecological, or utilitarian criteria
- Categorisation drivers seem to relate to the level of expertise and may also vary cross-culturally
- Geography is an interesting domain to study categorisation drivers, because of special properties relating to space, such as topology, mereology and scale, which may influence folk categorisations

2.1.3 Prototypicality, graded membership and free listings of category examples

Each category consists of a number of members that share some common attributes. However, not all members are equally good examples of a category (Mervis and Rosch 1981). *Sparrow* and *raven*, for instance, are considered good examples of the category *bird*, because they share many common attributes (e.g. they fly, have feathers and a beak). *Penguin* and *ostrich*, on the contrary, are considerd less typical examples of the category *bird*, because although they share some attributes with other members of that category (they have feathers and a beak), they lack others (they cannot fly).

The notion that some members are better examples of a category than others is expressed through the concept of prototypicality or graded membership (Rosch 1975; Mervis and Rosch 1981). Experiments to assess the strength of belonging between exemplars include asking subjects to rate sentences such as '*A penguin is a bird*'. Apart from the actual rating, the time that subjects took to answer was also found to be an indication of the strength of membership. Subjects took less time to rate the sentence '*A sparrow is a bird*' than '*A penguin is a bird*', suggesting response times are shorter for more typical examples. Another approach is to let subjects write down members for a given category in free listing experiments, such as examples for 'furniture', or 'animals'. Such experiments based on free listing are also known as 'category norm studies' (Battig and Montague 1969; van Overschelde, Rawson, and Dunlosky 2004). Such studies are usually conducted to define the elements of a cognitive domain such as 'colour' or 'food' for a cultural group (Berlin and Kay 1969; Hough and Ferraris 2010). The results of free listing can also be analysed for graded membership, because typical examples of categories were found to often be those that were listed more frequently across subjects (Mervis and Rosch 1981).

Although the domains investigated in most of these studies, such as 'furniture', are far removed from the geographic domain, some category norm studies included geographic categories among their examples. In the classic experimental psychology study on category norms, Battig and Montague (1969) elicited examples in over 56 categories from university students in the United States, one of which dealt with geographic phenomena as 'examples for a natural earth formation'. The most commonly listed example was *mountain*, followed by *hill* and *valley* (Battig and Montague 1969). In a study of geographic categories with university students in Buffalo in the United States that applied free listing, *mountain*, *river* and *ocean* were the most frequent categories listed as 'a kind of geographical feature' (Mark, Smith, and Tversky 1999). Using the same methodology in a cross-cultural comparative study with Portuguese university students, 4 of the 5 most frequent categories were the same as for American students in the Mark and Smith experiments (Mark, Smith, and Tversky 1999), but the differences in the rest of the top ten responses were more pronounced (Pires 2005). A similar study with Greek students used the phrases by Mark and Smith translated to Greek as elicitation for their experiments, and further tested for the differences in understanding of geographic concepts between 'experts' and 'non-experts' (Giannakopoulou et al. 2013). For 'non-experts' (Greek high-school students and first year college students) the most frequent categories were the Greek terms for *mountain*, *sea*, *lake*, *plain*, and *river* and for 'experts' (postgraduate students of a GIS course) they were *mountain, river, city, road*, and *sea* (Giannakopoulou et al. 2013).

As these experiments in different language settings of English, Portuguese and Greek produced comparable top ten frequency terms, this gave rise to the argument that geographic category norms may be shared cross-culturally (Pires 2005). The 'non-experts' in all the aforementioned studies were students who had more or less recently gone through geography classes at high

school and were responding to a questionnaire in classrooms. These students represented a fairly homogenous sample of educated, young people who grew up in an urban environment in a Western cultural context, speaking different European languges. It is therefore questionable to what extent findings of such studies can be used to infer the conceptualisation of the geographic domain of a broader population. Comparing such conceptualisations between different Western contexts may reveal little about cross-cultural differences in categorisation. Furthermore, such experimental studies reveal nothing about the real-world underlying referents, that is, the actual geographic features and their properties.

In biology, more ethnographic approaches were used to study non-expert or folk categorisations (Atran 1998; Berlin 1992; Hunn 1975). However, until recently, little ethnographic work dealt with folk categorisation of the geographic domain. Notable exceptions are, for instance, early work on rainforest habitat classification (Posey 1985), and the previously mentioned study on folk soil classifications in Peru (Furbee 1989). In general, folk soil classifications seem to have received comparatively more attention than other subdomains of geography, probably because of their relation to agriculture (Talawar and Rhoades 1998). More recently, researchers also started using ethnographic approaches at the intersection of cognition and GIScience. For example, in their study on landforms in Portugal, Williams et al. (2012) used free listing combined with videos of landscapes. Inhabitants of two villages in Portugal watched two videos of landscapes, one of the landscape around their own village and another of the landscape around the other, unfamiliar village. After the video stimuli, the researchers interviewed participants to elicit landform categorisations. The results showed how familiarity with landscapes increased the number of terms listed, as familiar landscapes triggered memories of nearby areas not shown in the videos, for which participants then also listed terms (Williams, Kuhn, and Painho 2012). However, in that study the authors filtered the elicited terms according to their own perception of what constituted a valid 'landform', and did not report all the terms participants had mentioned, which were reported in the original thesis (Williams 2011).

In our study on commonsense geographic categorisation in Switzerland, we used outdoor elicitation tasks with participants in two mountain areas and an urban park (Wartmann et al. 2015). Results revealed that the landscape where experiments took place influenced the categories listed, with, for example, only participants in the mountain area where there was a glacier nearby listing *Gletscher* (*glacier*) as a category in their free list. Such location-specific landscape categories often occurred towards the end of lists, while more general categories such as *Berg, Tal, Wald* (*mountain, valley*, and *forest*) were most cognitively salient, in other words, more frequent and occurring towards the beginning of lists, indicating they are also more typical examples (Wartmann et al. 2015). In a pre-test, participants did not understand the elicitation phrase on 'geographic categories', but comfortably listed categories in response to the Swiss-German question: '*Was hätts für Sie inere Landschaft*', which would be literally translated to English as '*What is there for you in a landscape?*' (Wartmann et al. 2015). Such elicitation phrases are crucial in experiments on commonsense geographic categories, as they influence results (Smith and Mark 2001). First and foremost, the phrase needs to be understood in everyday language. In our study on landscape terms in Switzerland, compared with elicitation phrases that contained the expression 'geographic feature', or 'geographic category' that participants did not understand well, participants readily listed categories when prompted with an elicitation phrase on 'what there is in a landscape'. However, landscape is not only a term understood in everyday language; it is also the focus of studies in different scientific fields that are introduced in the next paragraphs.

Key messages Prototypicality, graded membership and free listing of category examples

- Not all members of a category are equally good or prototypical examples of that category
- Typical examples of a category can be elicited through free listing experiments
- Free listings on geographic categories were often conducted indoors and with university students as subjects
- Landscape appears to influence categorisation by triggering memories of familiar places for which geographic categories are then recalled

2.2 Landscape

Landscape is a commonly used concept in a range of scientific fields, such as landscape ecology (Kirchhoff, Trepl, and Vicenzotti 2012; Troll 1950; Wiens 1999), geography (Backhaus et al. 2008), linguistics (Burenhult and Levinson 2008; Mark et al. 2011b), anthropology (Hirsch and O'Hanlon 1995), and landscape ethnoecology (Johnson and Hunn 2010b). But where did the term originate, and how is landscape defined and investigated in these different research fields? In the following, the origins of the term 'landscape' are outlined, before different notions of landscape are introduced.

2.2.1 Origins of the landscape concept

Etymologically, the German term *Landschaft* is of ancient Germanic origin and combines the noun *land* (land) with the verb *scapjan* (to work, be busy, to do something creative with a plan in mind), forming the terms *landscape* in English, and *landschap* in Dutch. In Roman languages the terms *paisaje* in Spanish, *paysage* in French, and *paesaggio* in Italian stem from the Latin word *pagus*, originally referring to extents of land fixed by markers (from the Latin verb *pangere*, meaning to fix or fasten), and later to rural districts or more generally, the countryside (Mitchell, Rössler, and Tricaud 2009; Haber 1995). Although uses of the German term *lantskaf* as translations of the Latin *regio* date back to gospel harmonies in 830 AD (Troll 1950), the wider adaptation of the term landscape is chiefly attributed to the Renaissance period. Instead of painting portraits or scenes containing people, many painters focused their attention on the land, embossing a view of landscape as scenery or essentially as a 'viewscape' (Gibson 1989). Later, in Romanticism, landscape painters turned to gardens and imagined or idealised wild spaces for inspirations (Hirsch and O'Hanlon 1995; Mitchell, Rössler, and Tricaud 2009). Rather than depicting certain locations as they were, for instance, when it was raining, landscape painters sought to synthesise the most beautiful aspects (according to their value judgement), such as weather, lighting conditions and landscape elements at different locations into idealised landscape paintings. English Romanticist painter William Turner (1775-1851) remarked:

To select, combine and concentrate that which is beautiful in nature and admirable in art is as much the business of the landscape painter in his line as in the other departments of art.

William Turner, around 1810 (Shanes 2012, p. 60)

Through their practice of painting mostly the 'natural' elements of landscapes, painters fostered the notion of idealised 'wild' landscapes devoid of people. Such notions are, for instance, also reflected in the practice of landscape gardening, where these idealised and imagined landscapes were recreated in the real world (Mitchell, Rössler, and Tricaud 2009). Given its origins in landscape art and gardening, how did the landscape concept get taken up into science?

At the beginning of the 19th century, naturalist and bio-geographer Alexander von Humboldt coined one of the first scientific definitions of 'Landschaft' as the 'total character of a region of the earth' and he is considered to have laid the conceptual grounds for landscape ecology (Haber 1995). Later, Carl Troll helped develop landscape ecology as a major scientific field,

which conceived landscape as a mosaic-like composition of different ecological units, ranging from the smallest units called 'ecotopes' (Troll 1950; Tansley 1939) to entire ecosystems. Although the roots of landscape as a scientific concept are in landscape ecology, the focus of this thesis is less on the ecological foundations of a certain extent of the Earth's surface, but more on how people perceive landscape. The following sections therefore introduce bodies of literature on how people parcel up landscape into different culturally recognised units, and attach meaning and feelings to certain landscape types and places.

Key messages Origins of the landscape concept

- The term 'landscape' has Germanic roots that refer to the influence of humans working and shaping the land
- Landscape painters adopted the term to refer to imagined and romanticised 'wild' and beautiful places
- Alexander von Humboldt adapted the concept of landscape to science and defined it as the 'total character of a region of the earth'

2.2.2 Psychological approaches to landscape perception

In dealing with landscape, the first step to categorisation is the perception of the environment through the senses, that is, the processing of sensory input and information into meaningful experience (Bernstein 2013, p. 85). Many psychologists dealt with perception of the environment, notably, J. J. Gibson, who, in his 'ecological approach to visual perception' (1979) postulated that an animal and the environment were an inseparable pair, and the environment was what an animal perceived at any given moment. Gibson used the term 'affordance' to refer to opportunities for action provided by any given object or environment:

The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill.

(Gibson 1979, p.127)

Gibson argued that, for instance, a path afforded locomotion from one place to another, and a cliff afforded falling, and that these affordances were what animals (and humans) perceived when they perceived an environment. Following this line of argument, when we perceive a landscape, we would thus perceive its affordances, and not its qualities (Smith and Mark 2003). Although the concept of affordances has become widely used in psychology, and is also referred to in studies on geographic categorisation (Smith and Mark 2003), often synonymous with 'utilitarian aspects' (Williams, Kuhn, and Painho 2012) 'affordances' and 'utilities' should not be treated as synonyms. According to Gibson, the affordances an environment offers to humans can be instantly perceived. This seems an overly simple assumption. For example, a road affords not only locomotion from one place to another, it also affords dancing, colouring with chalks, sunbathing, and for some people, sleeping and many other activities, and it is doubtful that such a wide range of affordances can be simply 'instantly perceived'. Furthermore, if affordances were instantly perceived, this would suggest cultural homogeneity. Therefore, in this work, I adopted the concept of 'utilitarian aspects' of landscape, namely that people from different cultures interact with and use landscapes in different ways (Hunn 1982; Posey 1984).

Another psychological approach to the perception of environments is Montello's (1993) classification of scales of perception of space. These include *vista space* as a space that can be apprehended from a single vantage point, *environmental space*, which is too large to apprehend from a single viewpoint and thus requires information to be integrated over time, and *geographical space*, which is commonly learned from maps (Montello 1993). These different scales of perception have consequences for cognition, because people must somehow be able to store, retrieve and integrate information from memory for both *environmental* and *geographical space*. The concept of *transperceptual spaces*

(Downs and Stea 1977) essentially expresses a similar idea, that is, people having to integrate different perceptions of single perceptual spaces over time.

Key messages Psychological approaches to perception of the environment

- In Gibson's ecological approach to perception, he coined the term 'affordances', which he postulated were instantly perceived
- Although affordances have been used in literature on geographic categorisations, the underlying assumption is that of cultural homogeneity, which might be overly simplistic
- Another psychological approach to perception is Montello's scales of perception of space, with the scale of *environmental space* linking to landscape

2.2.3 Cultural landscapes

Landscapes shifted into the focus of geography in the early 20th century, for example with Finnish geographer Johannes Gabriel Granö, who promoted the study of landscapes and regions in his attempt to provide the nascent science of geography with a unifying subject-matter (Granö 1929). In his work, Granö focused both on the identification and descriptions of geomorphological features of landscapes, as well as on human economic activities in different landscapes, for example in Finland, Estonia and Mongolia (Granö 1929; Granö and Granö 2003). In the mid 20th century, geographer Carl Sauer highlighted the importance of culture shaping landscapes, which contrasted with earlier scientific views of landscapes as being entirely the product of biophysical processes shaping the Earth's surface. Sauer is therefore widely regarded as having coined the concept of 'cultural landscapes' that consist of physical features acted upon and influenced by cultural forces (Sauer 1925).

The term 'cultural landscapes' has also been taken up in policy making and management, for instance in the World Heritage Convention in 1992, which seeks to recognise and protect cultural landscapes all over the world (Mitchell, Rössler, and Tricaud 2009). The World Heritage Convention defines a cultural landscape as representing 'combined works of nature and of man' (UNESCO 1972). However, the entries in the current World Heritage List and their subcategorisation into 'natural' and 'cultural' landscapes highlight how the dualism of nature/culture still persists and how few cultural landscapes are actually categorised as 'mixed' (UNESCO 1972).

The concept of cultural landscapes conceptualises people as a part in shaping landscapes (similarly to biophysical processes). However, the meanings and feelings people attach to landscapes and specific landscapes received less attention, which was addressed in a large body of literature concerned with the concept and meaning of place in anthropology and human geography, which is introduced in the next section.

Key messages Cultural landscapes

- Johannes Granö promoted landscapes and regions as a unifying subject matter for the nascent science of geography
- Carl Sauer highlighted the importance of culture as a force in shaping landscapes
- Cultural landscapes were adapted as a concept for science and policy-making by the UNESCO World Heritage Convention in 1972

2.2.4 Anthropological views on landscape 'between space and place' and sense of place

Anthropological interest in landscapes and places is relatively recent. Anthropologist Keith Basso expressed his surprise about this lack of anthropological interest in the study of landscape and places:

Sensitive to the fact that human existence is irrevocably situated in time and space, and keenly aware that social life is everywhere accomplished through an exchange of symbolic forms, anthropologists might be expected to report routinely on the varieties of meaning conferred by men and women on features of their natural surroundings. Yet ethnographic inquiry into cultural constructions of geographical realities is at best weakly developed.

(Basso 1996, p. 53)

Hirsch and O'Hanlon (1995) tried to close this gap by publishing a collection of essays in 'An Anthropology of Landscape'. The title of the introduction to this edited volume 'Landscape: Between Place and Space' already highlights the intermediary position they attributed to the concept of landscape as a cultural process linking space and place (Hirsch and O'Hanlon 1995). Basso used 'sense of place' to describe the way in which people conceptualise landscapes and take themselves to be connected to them. In this sense, space as a more abstract geometric representation acquires meaning through the multiple lived relationships that people maintain with places (Basso 1996, p. 53). In his ethnographic study on Western Apache sense of place, Basso describes the intricate relationships of Apache people with their landscape and how specific places link to a system of knowledge and morality, bringing to the fore how Apache people attach stories that contain useful knowledge and moral understandings to specific places (Basso 1996). In Basso's writings, the bio-physical environment is closely intertwined with cultural notions of it. The bio-physical environment and landscape elements such as trees, hills, trails and stream crossings at specific places form the basis for the cultural significance of these places. The landscape ethnoecological approach introduced in paragraph § 2.2.6 builds on this notion of the bio-physical parts of the environment that are closely linked with how people perceive and interact with landscape.

Anthropologist Tim Ingold rejected the idea of a culturally constructed 'layer' being added to a pre-existing bio-physical environment (Ingold 2000). Building on Gibsonian notions of ecological perception (Gibson 1979), Ingold suggested the world constantly came into being as people perceived it and lived in it, which he termed a 'dwelling perspective' (Ingold 2000). The dwelling perspective focuses on experiential knowledge of landscape, on the actions people perform and through which they come to know a landscape. Both Basso's sense of place and Ingold's focus on getting to know a landscape through experience are compatible with the landscape ethnoecology approach introduced in § 2.2.6.

While the study of place and landscape in anthropology is fairly recent, in geography, the study of place has a longer history, in which notions of place changed from the description of specific regions to place as an analytical concept for understanding the world (Cresswell 2006; Warf 2010). Place was even suggested to be the one unifying concept for geography:

Astronomy has the heavens, History has time, and Geography has place.

(Seamon and Sowers 2008, p. 1)

The importance of place for these research areas notwithstanding, the definition of place is not straightforward. For example, political geographer John Agnew defined three dimensions of place. The first dimension is *location*, or a site in space where an object is located that can be identified through a set of coordinates or an address. The second dimension is *locale* or settings where everyday activities and social life take place. The third dimension is *sense of place*, as the subjective and emotional attachment people have to place (Agnew 1987). Human geographer Yi-Fu Tuan defined this attachment to place or sense of place as 'topophilia', or, the 'affective bond between people and place or setting' (Tuan 1974, p. 4). Tuan (1974) examined factors for variation in environmental perception (e.g. biological environment, culture) before focusing on people's feelings and emotions

about place. Scholars such as Lofland (1975) criticised Tuan for having bypassed some essential, more basic work in his analysis on the variation in environmental perception, such as describing and comparing the perception of the environment of different groups of people in different landscapes. Furthermore, in their focus on the cultural aspect of place, anthropologists and human geographers were argued to have neglected the importance of the biophysical environment's contribution to shaping a sense of place (Stedman 2003). This research gap is the focus in the emerging fields of landscape ethnoecology and ethnophysiography discussed in § 2.2.6.

In the geographic literature there has been a considerable debate about the two fundamental geographic concepts of 'space' and 'place' (Cresswell 2006). Rather than seeing them as two opposing concepts, Edward Relph, for instance, emphasised that space is not just a container for places, but must also be explored in terms of people's experience (Relph 1976). One of Relph's contributions to the study of place is that he thus conceptualised space and place as a continuum of experience:

Relph sees space and place as dialectically structured in human environmental experience, since our understanding of space is related to the places we inhabit, which in turn derive meaning from their spatial context

(Seamon and Sowers 2008, p. 44)

Relph's work was criticised for ignoring the possibility of a more 'global sense of place' (Massey 1994). In her essay, Massey argues that reactionary interpretations of place as places reserved for what is constructed as a homogenous 'local community', can lead to self-enclosing and the rejection of outsiders, for instance, through the creation of gated communities. Instead, Massey calls for a relational rethinking of place as:

[…] articulated moments in networks of social relations and understandings, but where a large proportion of those relations, experiences and understandings are constructed on a far larger scale than what we happen to define for that moment as the place itself, whether that be a street, or a region or even a continent.

(Massey 1994, p. 154)

In her related work, 'For Space' Massey (2005) emphasises how such a relational understanding of space may overcome the opposition of space and place. For Massey space is interrelational, connected, open, always coming into being, and therefore never fully formed. Massey argued that adopting such an understanding of space (and place) affects our understanding of the world, and changes how we understand processes such as globalisation. Today, research on place continues to be important, because only if we can describe a place and what makes it special can we aim to maintain places that form an important part of people's experience of their environment. Although many forms of conveying meaning of places are possible, a large part of communication and descriptions of places is expressed through language, which is the focus of the next section.

Key messages Anthropology of landscape 'between space and place', and sense of place

- The concept of landscape takes an intermediary position between space and place
- In geography, the concept of place is important. Agnew defined three dimensions of space: *location*, *locale* and *sense of* place
- The concept of sense of place entails the multiple meanings, feelings and lived relationships people maintain with places
- Relph conceptualised space and place as a continuum of experience, and that space as well as place must be explored based on people's experiences
- Massey coined the notion of a 'global sense of place', emphasising a relational understanding of space

2.2.5 Landscape in language

How do people conceptualise their environment and how do they express their conceptualisations in language? Despite the potential of studying how the relationship between people and landscape is encoded in language, linguists only recently started investigating these questions in more detail (Mark et al. 2011a). From recent publications in linguistics, three angles can be identified from which to look at landscape and space in language:

- how people refer to the location of objects in space (spatial reference systems)
- how people reference specific places (toponyms)
- how landscape features are coded in language and expressed in language usage (landscape vocabulary)

So far, the focus in linguistic research has been more on spatial reference systems (Levinson 2003). Some work has dealt with the importance of toponyms (e.g. Senft 2008; Hunn 1996; Cablitz 2008; O'Connor & Kroefges 2008), but relatively little attention was paid to generic landscape terms (Mark et al. 2011a). This thesis focuses on what generic landscape terms (landscape categories) people use to refer to geographic features in a landscape.

In the following, I first introduce the semiotic triangle that models the relation between words, concepts and real-world objects, and then discuss the body of literature on generic landscape terms as the focus of my thesis.

Landscape, language and thought in the semiotic triangle. The semiotic triangle (Ogden et al. 1923, Fig. 1) is a useful model when we deal with how people think about geographic features, and how they express these thoughts in language. The triangle depicts the relationship between linguistic symbols, the concepts they represent (reference), and the real-world objects they refer to (referents).

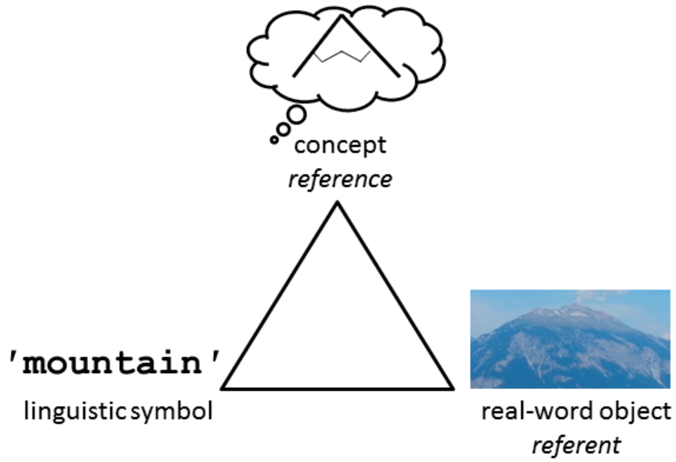

Fig. 1 Semiotic triangle for the geographic feature 'mountain'

The semiotic triangle can be explained as follows: the word *mountain* is a linguistic symbol that is associated with the concept of 'mountain', and via this concept, links to real-world underlying referents of mountains known as the 'Matterhorn' or the 'Aconcagua'.

Although the semiotic triangle depicts direct links between word, concept and underlying referent, current linguistic research questions these direct links. As Levinson states:

Linguistic semantics is not conceptual structure […] - it is a mere pale shadow of the underlying mental systems that drive it.
(Levinson 2003, p. 15)

Yet, even investigating such 'pale shadows' of thoughts expressed in language has the potential of revealing differences between languages and cultures that allow exploring how people think about the world around them. Thus, the semiotic

triangle constitutes a useful model for understanding the distinctions between words (terms, or symbols), the ideas or concepts behind them (references), and the real-world things (referents, instances, or objects) they refer to.

Key messages Semiotic triangle
- The model of the semiotic triangle depicts the relationship between linguistic symbols (words, or terms), the concepts they represent (reference), and the real-world objects they refer to (referents)
- Current research in cognitive linguistics questions the direct links between words, concepts and referents

Generic landscape terms[2]. Linguists and geographers became interested in generic landscape terms, because landscape is a cognitive domain that, similar to the human body or kinship relations, is central to human experience and therefore offers an ideal basis for comparative studies across the globe (Levinson and Burenhult 2009; Burenhult and Levinson 2008). Indeed, the empirical evidence from studies on landscape terms points to a large cross-cultural and cross-linguistic variation in how people conceptualise landscape (e.g. edited volume on *Landscape in Language* by Mark et al. 2011a), and studies such as Bromhead 2011; Burenhult 2008; Cablitz 2008; Enfield 2008; Huber 2014; Kathage 2009; Klippel et al. 2015; and Rybka 2014. It is beyond the scope of this thesis to provide an overview of linguistic studies on generic landscape terms and their grammaticalisation. In this body of literature, the degree of variation in generic landscape terms is of most interest for this thesis.

[2] Some ideas that I elaborate in this paragraph originated in work conducted during a 2 week visit at Lund University in Niclas Burenhult's Language, Cognition and Landscape (LACOLA) research group

In the following, I therefore highlight some major findings. Firstly, there is variation between landscape terms within a single language, as, for example:

> the term *beck* 'brook or stream often with rugged course' seems to be confined to certain dialects of British English and the term (borrowed from Spanish) *arroyo* 'dry riverbed' is only used in some varieties of American English. To take another case, the terms *brook* and *woods*, found in both British and American English, are not used in Australian English.
>
> (Bromhead 2011, p. 62, emphasis in original)

Another example for the variation of landscape vocabulary within a language is the study on landform categories in Portugal, where elicited terms for landforms differed between people from two different villages (Williams, Kuhn, and Painho 2012).

Secondly, landscape terms are not easily translatable between different languages, because underlying concepts may differ even for closely related languages (Huber 2014). For instance, in her study on the conceptualisation of watercourses, Bromhead (2011) also noted that French speakers distinguish *fleuve* (large watercourse which flows into the ocean), and *rivière* (watercourse that doesn't flow into the ocean), while English speakers do not make this distinction. German is a similar case as French, where the terms *Strom* (large watercourse that flows into the ocean) and *Fluss* (watercourse that doesn't flow into the ocean) are distinguished.

Thirdly, there appear to be very few, if any, universal landscape concepts. Not every culture and language necessarily has a term that matches the concept of what many English speakers see as basic geographic concepts, or category norms (Battig and Montague 1969). For instance, there is no lexical equivalent to *island* in the Makalero language spoken in East Timor. Makalero speakers did not conceptualise the 'island' they were living on as

an island, but as 'land'. They explained the lack of a Makalero term for 'island' with the absence of small oceanic islands in their traditional homelands (Huber 2014).

Moreover, the absence of a real-world referent in the territory of a speech-community does not necessarily lead to a lack of generic landscape term for that referent. In Australia, the Yindjibarndi have a term *thanardi* (ocean, sea), although current Yindjibarndi country has no access to the sea (Turk, Mark, and Stea 2011). Thus, either ancient Yindjibarndi country once extended to the ocean, so that Yindjibarndi speakers coined a term for this phenomenon that was maintained in the lexicon until today, or, the landscape term *thanardi* is a loanword from a language of a speech-community that has access to the ocean, although this could not be confirmed with existing dictionaries (David Mark, pers. comm.).

In general, where there are no words for certain phenomena in a language, this is called a 'lexical gap'. Such gaps are often filled by borrowing words from other languages (Haspelmath 2009). Although the 'World Database on Loanwords' claimed the 'physical world' was among the semantic fields most resistant to loanwords (Haspelmath and Tadmor 2009), loanwords are commonly found in the landscape vocabulary. For instance, in the Jahai language spoken on the Malay Peninsula, of 34 simplex nominal landscape terms, 15 were loanwords. An example is the term *tbiŋ* (mountain-side, slope) from Malay *tebing* (bank) and *lata* (waterfalls) from dialectal Malay *lata* (waterfall) (Burenhult 2008, p. 189). Interestingly, waterfalls are perceptually salient in the Jahai landscape and also culturally important landscape features with mythical significance, yet there is no indigenous term for the English concept of a waterfall. It thus appears whether or not a landscape term is a loanword does not allow one to make any conclusions about the cultural importance of the landscape feature.

Key messages Generic landscape terms

- Differences within a language: there is variation between landscape terms within certain dialects or local variants of a single language
- Differences between languages: because of differences in underlying concepts, landscape terms are not easily translatable and there may be very few, if any, universal landscape concepts

Grammaticalisation of landscape terms. In some languages, landscape terms are transparent compounds that allow inferences about the qualities of underlying referents. For instance, in the Seri language spoken in Mexico, complex landscape terms consist of one of four substance terms *hast* (stone), *hax* (fresh water), *xepe* (sea-water) and *hant* (ground, land) (O'Meara and Bohnemeyer 2008). The landscape terms *hax cactim* and *xepe cactim* both refer to a lagoon, one in freshwater and the other in salt-water. Although a distinction based on whether a water body contains salt or fresh water is also made in other languages, in the Seri language, the generic landscape term always contains the term for the substance of the underlying referent, such as *hast* (stone) in the landscape term *hast quih i-yat* (summit of a mountain) (O'Meara and Bohnemeyer 2008).

Toponyms also often contain generic landscape terms. However, there is a scholarly debate about whether or not toponyms are pure referencing expressions or whether they can sometimes be informative of the properties (e.g. topography) of the underlying referents, that is, the places they refer to (Coates 2006; Hollis and Valentine 2001). For instance, the Eiffel Tower is a tower, but there may or may not be a hill at the locations referred to as 'Black Hill' in the United States (example from Derungs et al. 2013). In our study on generic terms contained in Swiss mountain toponyms, we therefore investigated whether the generic terms *Horn* (horn, e.g. in Matterhorn), *Spitze* (peak) and *Berg* (mountain) contained information about the topographic properties of the underlying referents (e.g. slope and relative drop of a

buffer zone around the georeferenced toponym, Derungs et al. 2013). Buffer zones of groups of toponyms with the generic parts *Spitze* and *Horn* showed similar topographic patterns to those expected from the semantics of the generic terms (e.g. steep slope, large relative drop), whereas the buffer zones for toponyms containing *Berg* (mount, mountain) showed no consistent pattern. A possible explanation for the lack of a consistent pattern was, for example, that for the toponym 'Uetliberg', the etymology of the term showed that *Berg* related to *Burg* (castle). Thus, Uetliberg may never have been conceptualised as a mountain, but as a location where there was a castle (Derungs et al. 2013).

Key messages Grammaticalisation of landscape terms

- In some languages, landscape terms are transparent compounds that allow inferences about the qualities of underlying referents
- Toponyms also often contain generic landscape terms, but there is a scholarly debate whether toponyms containing generic compounds are pure referencing expressions or whether they also allow inferences about the places they refer to

Cross-cultural and cross-linguistic variation in landscape concepts. In general, across different languages, utilitarian factors seem to strongly influence *what* geographic features are lexicalised, such as, for instance, hydrological features in dry areas (Bromhead 2011; Turk, Mark, and Stea 2011), or certain vegetation units with cultural or economic uses in rainforest environments (Parker et al. 1983). However, as the example with waterfalls in Jahai (Burenhult 2008) illustrated, not all culturally important landscape elements need to be lexicalised. Importantly, the cross-cultural variation lies not only in *what* landscape features people carve out of the landscape, but also in *how* different languages grammaticalise and lexicalise landscape features. Languages were thus stated to be similar to 'nets' that are 'thrown with different mesh sizes over reality' (Pelz 1996), which, for the domain of landscape, speaks to the variability in how people carve out and name different units out of the Earth's surface as landscape categories. This variability in landscape conceptualisations and terminology is the focus of emerging research areas outlined in the following sections.

Key messages Cross-cultural and cross-linguistic variation in landscape concepts

- Utilitarian aspects seem to be important in what landscape features are lexicalised, although not all culturally important elements need to be lexicalised
- There is a large cross-linguistic variation in how landscape features are encoded in language

2.2.6 Ethnophysiography

At the intersection of geography, linguistics and cognitive science, the field of ethnophysiography has emerged, which studies how people from different cultures categorise landscape features such as landforms, water features and vegetation assemblages, as well as the cultural beliefs and customs of peoples related to those features (Mark and Turk 2003; Turk et al. 2011). One of the driving questions in ethnophysiographic research is:

Do all people, from different cultural/linguistic groups, think about landscape in more or less the same way, or are there significant cross-cultural and cross-linguistic differences in the ways human beings conceptualize their environments at landscape scales?

(Mark et al. 2011b, p.7)

Early work in ethnophysiography focused on Yindjibarndi speakers in Western Australia, showing how for the Yindjibarndi people, spiritual aspects played an important role in conceptual-

isation of geographic features. For example, a permanent pool of water (*yinda*) always contained a spirit (*warlu*) (Mark, Turk, and Stea 2010), and thus, the geographic feature was inseparable from its cultural and spiritual significance. Another ethnophysiographic study with the Diné (Navajo) people in the United States showed how their conceptualisation of landscape features emphasised material, rather than size, with many terms beginning with *tsé* (rock) and *to* (water) (Turk, Mark, and Stea 2011). In these studies, the full potential of ethnophysiographic work has not been fully realised, as the method was experimenter-centred (experimenters asking consultants to name features the experimenters identified), and was not embedded in more in-depth ethnographic work into how the compiled landscape terms relate to how the Yindjibarndi or Diné people interact with and use landscape. Therefore the elicited term lists remain relatively isolated from their broader cultural context. The field of landscape ethnoecology tries to bridge this gap through interdisciplinary research at the intersection of ecology, anthropology and linguistics, with a methodical approach informed by all three research areas.

Key messages Ethnophysiography

- Ethnophysiography is a research area at the intersection of geography, linguistics, and cognitive science
- Research in ethnophysiography focused on how people from different cultures categorise landscape features such as landforms, water features and vegetation assemblages

2.2.7 Landscape ethnoecology

Landscape ethnoecologists are interested in uncovering the ecological foundations of how people make a living on the land, while also taking into account people's relationships and interactions with landscape. In their edited volume on landscape ethnoecology, Johnson and Hunn stated that:

Our focus is on the perception of the land, the parsing of its patterns, and the classification of its constituent parts in local ethnoecological systems, and on the significance of these understandings in the ethnoecology of local groups. We emphasize landscape as perceived and imagined by the people who live in it, the land seen, used and occupied by the members of a local community. It is a cultural landscape.

(Johnson and Hunn 2010, p.1)

In landscape ethnoecology, much attention has been paid to explore how people identify and use so-called 'folk ecotopes' (Johnson and Hunn 2010) or 'folk ecological zones' (Posey 1985). These folk ecotopes are emic landscape units or folk landscape categories that are culturally recognised by a group of people.

Studies identifying such folk landscape categories that may or may not have used the label landscape ethnoecology cover a wide geographic range. Much of the work focused on boreal landscapes of northern America (Aporta 2011; Davidson-Hunt and Berkes 2010; Johnson 2000; Royer and Herrmann 2012; Trusler and Johnson 2008). Some studies focused on tropical forests of Asia (Ellen 2010) and South America (Abraão et al. 2010; Fleck and Harder 2000; Halme and Bodmer 2007; Riu-Bosoms et al. 2014; Shepard Jr. et al. 2001), the savannas of the Gran Chaco (Scarpa and Arenas 2004), arid and semi-arid landscapes in Africa (Duvall 2008; Krohmer 2010), mountain areas in Europe and Asia (Meilleur 2010; Müller-Böker 1991), and grasslands (Molnár 2014).

Findings of these empirical studies suggest that different cultural groups indeed conceptualise their environment in different ways. The questions that emerged were: what are the reasons for the variations in how people categorise landscape? Is it the variation of landscape, language, culture, or indeed a combination of all of these that leads to different landscape categorisations? Methodologically, one way of assessing differences between conceptu-

alisations is to compare the extent of differentiation in the vocabulary for different, etically defined aspects of landscape such as vegetation, water, soil or topography. These externally defined groups of categories provide a simple way of comparing the amount of differentiation of landscape vocabulary.

Some researchers claim a direct link between the environment and the number of terms found in one of these defined categories. For example, Krohmer (2010) postulated that a varied topography of a landscape will result in a differentiated classification of units that relate to topographical characteristics. Furthermore, Krohmer claimed that in environments where a resource is scarce or 'ecologically salient', it will be more important and therefore more differentiated in the vocabulary.

There are two issues with these claims. First, given a landscape vocabulary (assumed to be relatively complete, or at least unbiased towards any etically defined landscape category such as water or vegetation units) we would be able to infer that what is lexically highly differentiated is either abundant or important, and what is absent or lexically undifferentiated is not abundant and not important. However, empirical evidence indicates that lexical differentiation is not necessarily a good indicator of abundance or importance. For instance, as discussed earlier, waterfalls are both abundant in the landscape in Jahai territory and mythologically important, yet there is no way (either as a nominal term or other) to express the concept of a waterfall in Jahai language (Burenhult 2008).

Second, who defines 'diversity' or 'scarcity' of what a landscape has to offer, both in terms of the diversity of landscape features and their utility? While measures exist for the biological part of the environment such as biodiversity, the diversity of the physical environment is more difficult to assess with existing methods. For example, are alpine landscapes with stark topographic contrasts more diverse than sandy deserts, and if yes, more diverse from whose perspective? For a Western-European, the landscape in the Sahel may look uniform and monotonous, but the pastoral Fulani who live in this environment identify over 100 landscape units (Krohmer 2010). The utility of parts of the landscape for certain groups of people with certain lifestyles may indeed play an important part in categorisation (Molnár 2014; Williams, Kuhn, and Painho 2012). Interpretations of lexical diversity in landscape categories therefore need to be exercised with caution, and there is a need to accompany such interpretations with ethnographic work on how people interact with landscape.

Given that the variation in the physical environment may, to some extent, influence the variation in landscape categorisation, several studies investigated how people from different cultures conceptualise the 'same' landscape. The expectation of such compar-ative studies was that they would yield insights into how people from different cultural backgrounds speaking different languages 'think and speak about the same landscape and the same referents in different ways using words with different meanings' (Bromhead 2011, p.60).

Settings where the influence of culture and language on landscape categorisation can be studied are rare. Often, less than optimal comparisons have been made. For instance, a study compared landscape conceptualisations of the Diné (Navajo) in North America occupying semi-arid landscapes with exposed rock formations and the Yindjibarndi in northwest Australia living in a dry landscape with sparse vegetation and no permanent watercourses (Mark, Turk, and Stea 2011), assuming that these landscapes were comparable. The notion of similarity between these landscapes, however, was entirely based on the researchers' own perception, rather than on consultants of the two speech communities rating the other landscape as 'similar' to their own. Another comparative study looked at differences in vegetation terminology between the Nualu on the Maluku Islands in Indonesia and the Matsigenka in the Peruvian Amazon (Ellen 2010). The researchers judged the respective landscapes to be similar, be-

cause they were both tropical rainforests. In fact, despite their apparent similarities, the rainforests where the Nualu and Matsigenka people live differ not only in the plant and animal communities they contain, but may also vary in topography, and other factors, which considerably limits any conclusions that can be made from such comparisons. Another study elicited landscape categories for the same landscape from native Navajo speakers with photographs taken in Navajo country and compared the Navajo categorisation with the descriptions of these pictures with English speakers recruited through Amazon Mechanical Turk (Klippel et al. 2015). Although in this study, the landscape for the comparison was the same for the two groups of speakers, the Navajo speakers were highly familiar with their country, while English speakers recruited online were not.

A study in western Alaska compared landscape conceptualisations of Athabascan and Inuit-Yupik groups that belong to two unrelated languages, but have overlapping or adjacent homelands with little contact-induced influence on their respective languages (Holton 2011). Although Athabascan and Inuit-Yupik speakers may in parts occupy the same landscape, their landscape conceptualisations differed from each other. For the Yupik-Inuit conceptualisation of topographic eminences, shape was important, as the Inupiaq term *piŋuq* literally means not only 'hill' but also 'swelling'. Athabascan on the contrary places importance on size (Holton 2011).

Another comparative study from the boreal North looked at Kaska, Witsuwit'en and Gitksan landscape terminologies to explore the influence of language, landscape and ecology (Johnson 2011). Johnson suggested nuances in landscape terminologies of these groups reflected their interaction and particular attention to different aspects of the landscape. For example, the Gitksan who navigate on the large rivers in their territory have a fine-scaled hydrological terminology, including terms such as *ts'iliks* (where water barely covers a rock, but there is no wave). The

Gitksan people also travel in the mountain for hunting and berry picking, and have a detailed vocabulary on different aspects of mountains (Johnson 2011).

Focusing on the cultural and linguistic identification of landscape categories, the properties of the underlying referents and the cultural meanings people attach to these referents, the field of landscape ethnoecology closes the gap between the concept of sense of place in anthropology and human geography and studies on the ecological and physical properties of landscapes. Based on landscape ethnoecological work, the question arose of how such nuanced local understandings can be better represented on maps and in GIS (Johnson 2010a). The next section deals with how knowledge is produced in GIS, and how local knowledge has been represented in GIS.

Key messages Landscape ethnoecology

- Landscape ethnoecology is a research area at the intersection of ecology, anthropology and linguistics that focuses on culturally identified landscape units, their ecological underpinnings and their significance for how local groups make a living from the land
- Comparative studies showed that culture, landscape and culture may influence landscape categorisations

2.3 Geographic knowledge production through GIS

This thesis focuses on people's conceptualisations of landscape and how these are represented in language. These linguistic expressions provide a way to explore how such commonsense concepts can be represented on maps and in computational environments such as Geographic Information Systems (GIS).

This section first introduces Geographic Information Systems (GIS), the research field of GIScience (§2.3.1), and the critiques of GIS (§2.3.2). Within the field of GIS, several research strands such as participatory GIS (§2.3.3) and qualitative GIS (§2.3.4) are identified as a particularly relevant background for this thesis, be-

cause they aim to address critiques about GIS. The challenges identified within these different fields then raise more fundamental questions on the structure and production of geographic knowledge through GIS, which are introduced in the section on ontology research (§2.3.5).

2.3.1 GIS and GIScience

Geographic Information Systems (GIS) are computerised systems for collecting, managing, analysing and visualising spatial information (Maguire 1991). The history of GIS goes back to the 1960s, when the first GIS were developed for governmental and research purposes (Goodchild 2010). The term 'GIScience' refers to a research area that aims to go beyond the technology of GIS, as it deals with broader research questions revolving around GIS. One of the more holistic definitions is that GIScience is:

the basic research field that seeks to redefine geographic concepts and their use in the context of geographic information systems. GIScience also examines the impacts of GIS on individuals and society, and the influences of society on GIS. GIScience re-examines some of the most fundamental themes in traditional spatially oriented fields such as geography, cartography, and geodesy, while incorporating more recent developments in cognitive and information science. It also overlaps with and draws from more specialized research fields such as computer science, statistics, mathematics, and psychology, and contributes to progress in those fields. It supports researching political science and anthropology, and draws on those fields in studies of geographic information and society.

(Mark 2003, p. 2)

However, the GIScience research community has not (yet) fully embraced such a holistic view of GIScience, and often, the term GIScience is used to refer to any research involving the use of GIS

(Mark 2003, p. 2). Despite its considerable potential, GIS technology and its use in practice and research was criticised both from researchers outside and within GIScience (from the latter, a research field emerged that became known as 'Critical GIS'). The following section outlines different aspects of critiques of GIS and the research area of Critical GIS.

2.3.2. Critiques of GIS and Critical GIS

While in geographic research, some embraced GIS technology as an efficient way of dealing with increasing volumes of data, the use of GIS for geographic research was also criticised (Schuurman 2000). In the 1990s, human geographers argued, for example, that GIS did not produce geographic knowledge and that research using GIS was in fact 'high-tech trivial-pursuit' (Taylor 1990). These very fundamental critiques were rebutted by GIS researchers (Openshaw 1991) and did not result in a more critical engagement with the technology by GIS practitioners and researchers. In the mid-nineties, concerns voiced by human geographers became more nuanced and attempted to affect both GIS technology and practice (Schuurman 2000). For instance, Pickle's influential edited volume *Ground Truth* brought into question the social implications of GIS, and issues of spatial representations and power (Pickles 1995). Other critiques focused on the lack of participation of the local population in the production and use of geographic information (Abbot et al. 1998; Craig, Harris, and Weiner 2002), or, on the focus on quantitative data (Cope and Elwood 2009).

These critiques notwithstanding, GIS became widespread to communities all over the globe for a diversity of applications. The dissemination of GIS technology and associated mapping methods to indigenous peoples raised particular concerns, because exporting GIS to cultures outside the context of Western cartographic conventions may transform the way in which people represent and transmit geographic information (Johnson 2010a;

Rundstrom 1995). Several research fields since developed in which these critiques were taken up. In the following sections, I outline three research areas that address some of these critiques:

- § 2.3.3 Participatory GIS and participatory mapping (addressing the lack of participation)
- § 2.3.4 Qualitative GIS and representations of local knowledge (addressing the inclusion of other types of information)
- § 2.3.5 Ontology research (addressing ontological issues and the production of knowledge through GIS)

2.3.3 Participatory GIS (PGIS)

Participatory GIS (PGIS) evolved out of Participatory Learning and Action methods in the development context (Chambers 1994), which were merged with GIS methods and technology (Abbot et al. 1998). The declared goal of PGIS is to empower local communities by involving them more directly in the production and use of geographic information for decision-making (Weiner, Harris, and Craig 2002). Many PGIS initiatives applied some form of participatory data collection, which may take the form of people using handheld GPS devices for mapping, drawing on aerial images or topographic base maps, and people drawing hand-drawn maps on blank paper. In the following, I distinguish between maps drawn on geographically referenced base maps and sketch maps, which are unconstrained by predefined cartographic base maps. Then, some of the ways PGIS have been implemented and the challenges identified in such initiatives are discussed.

Participatory mapping using geographically referenced base maps. In many participatory mapping approaches, people draw on spatially referenced base maps such as topographical maps (Fig. 2), or on aerial images. The drawings are then often digitised to be represented in a GIS. In research, such maps have often been used in qualitative ways, for instance, to investigate where people with low-incomes access welfare services (Matthews, Detwiler, and Burton 2005), where children go out to play in a city (Wridt 2010), or where indigenous people go hunting and fishing (Tobias 2009, Fig. 2).

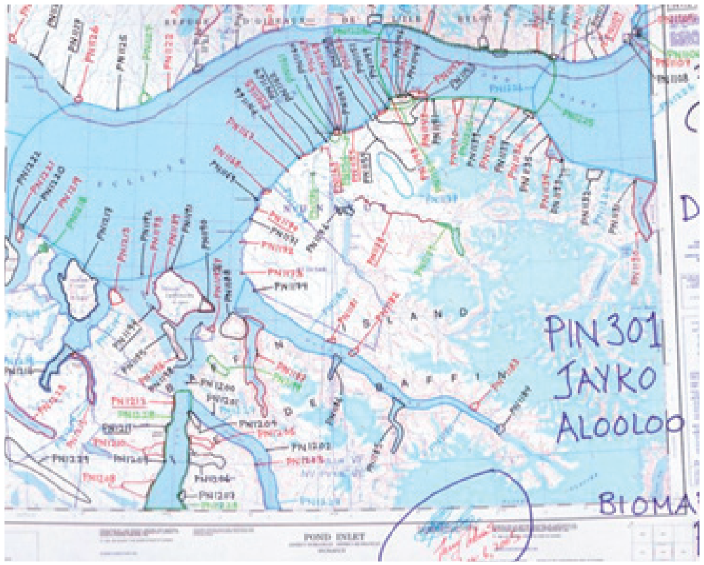

Fig. 2 Example of mapping indigenous knowledge of fishing spots on a topographically referenced base map (from Tobias 2009)

Another application of such participatory mapping for research was to let participants draw vague or vernacular regions on maps to link people's geographic concepts to actual space, such as in the seminal study on the question 'Where's downtown Santa Barbara' (Montello et al. 2003). Furthermore, such maps have been applied to link experiences and feelings to locations, for example, where people feel unsafe in a city (Wridt 2010). Linking feelings with particular locations on a map relates to sense of place studies in anthropology. However, this link between delineating areas on a map associated with certain feelings and the concept of sense of place is rarely made explicit.

Participatory mapping using geographically referenced base maps was linked directly to political ecology, in a particular strand of participatory mapping called 'counter-mapping', where the aim is to visualise local, often marginalised views on official maps to counter more dominant viewpoints. One of the most prominent examples is Peluso's study (1995) on mapping local views on forest resources in Indonesia.

Several indigenous mapping projects had similar goals, namely, to legitimise and render visible indigenous uses of the land and knowledge tied to specific places (e.g. Gearheard et al. 2011; Tobias 2009; Aporta and Higgs 2005). To use participatory mapping on georeferenced base maps (on its own or as a basis for PGIS) can be a conscious choice for interacting with the state, because the spatial representations on standard maps and GIS are often recognised and legitimised by the state itself (Leszczynski 2009). Using such forms of representations in negations with the state therefore make use of power relations embedded in the standard maps used as base maps during the mapping process (Crampton 2001). Digitising geographically referenced participatory maps for the use in PGIS tends to further amplify this power, because as a scientific technology, GIS validate and render authoritative the geographic information they contain (Sheppard 1993). However, because base maps are spatially accurate and the information from the participatory maps is overlaid on these maps in a GIS, the participatory maps may be mistaken as being spatially accurate themselves (Boschmann and Cubbon 2014). There is thus need to acknowledge the situated nature of spatial knowledge represented on participatory maps, also when they are digitised in GIS.

A critique of participatory mapping using georeferenced base maps was that representing knowledge on standard cartographic maps and in GIS may also transform this knowledge by fitting it to such representations, and distorting it in the process (Johnson 2010a). I discuss this critique in sections § 2.3.3 on Qualitative GIS and § 2.3.4 on ontology research.

Key messages Participatory mapping using geographically referenced base maps

- In participatory mapping using geographically referenced base maps people draw on base maps such as topographical maps or aerial images.
- Participatory mapping using geographically referenced base maps was used as a research tool for data collection, as well as for making visible local viewpoints and uses of space.

Sketch mapping. Sketch mapping is a participatory form of mapping where people draw their ideas and knowledge about places without constraints by pre-given cartographic representations. People are usually asked to produce sketch maps by drawing with pencils on blank sheets of paper (e.g. Fig. 3). Other materials may also be used for sketch mapping, such as drawing with sticks in the sand or with coal on wood. It is important to note that sketch maps are constrained by what people can represent using the materials they were given for the task.

Fig. 3 Example of a sketch map from a community-mapping project in Kenya (own picture)

Sketch maps have their roots in behavioural geography and psychology, where they were often referred to as 'mental maps' used for understanding human behaviours based on how people perceived their environment (Downs and Stea 1977; Kitchin 1994; Tversky 1993). In the behavioural geography tradition, scholars argued that people had mental images of their surroundings, and that these images could be investigated through mapping to access people's concepts of space (Kitchin 1994). Sketch mapping was therefore used to study spatial decision-making and way-finding, but also to access perceived spatial relationships and knowledge about places (Boschmann and Cubbon 2014; Kitchin 1994). When drawing a sketch map this process is similar to a memory task, because people need to recall elements in space and their relation to each other. During sketch mapping experiments participants are thus conducting a memory search for the geographic concepts they want to represent on the map, which links to our study about landscape categories and memory search (Wartmann et al. 2015).

By analysing sketch maps and the represented landscape categories, we may learn about how people abstract their environment in a map-like form, and, which elements they choose to represent, while forgetting, or deciding not to represent, others. However, the term map was criticised as an unfitting metaphor for representations of knowledge about our environments, because these representations were argued not to be maps at all, but to be 'cognitive collages' of separate pieces of information such as:

> *[…] memory snippets of maps we've seen, routes we've taken, areas we've heard or read about, facts about distances or directions*
>
> (Tversky 1993, p. 21)

The concept of the 'cognitive collage' highlights the importance of other forms of knowledge about places, but it omits that people do not only remember facts, but also associate feelings and memories with certain places (Basso 1996; Hirsch and O'Hanlon 1995; Johnson 2010a), which may difficult to represent on pen-and-paper maps. This challenge notwithstanding, sketch maps have often been used as a method to study local or indigenous knowledge of space, because they are less dependent on standard cartographic representations than participatory maps drawn on georeferenced base maps.

The study of sketch maps helped to reveal the conceptualisations of indigenous peoples and their spatial knowledge. For example, the Anuta on the Soloman islands maintained a detailed knowledge about seafloor geography and identified different types of reefs and their locations (Feinberg et al. 2003). Another example are the Maori in New Zealand, who have a rich mapping tradition. When researchers prompted Maori people to draw maps, they readily did, but the researchers puzzled over the fact that:

while the maps contain information, they also seem empty of information; there is much more that could have been said

(Kelly 1999, p.27)

Kelly relates this to the existence of other non-written forms of mappings, such as songs and other performative ways of conveying geographic knowledge, which relates to the term 'cognitive collage' discussed before (Tversky 1993), and the detailed folk landscape vocabulary of many groups (e.g. Mark et al. 2011a), including cultural and sacred notions of places and features such terms refer to, which people may or may not chose to represent on a map.

Therefore, sketch maps must be carefully interpreted in their cultural context, and attention needs to be paid not only on what the maps portray, but also on what they do not portray, that is,

folk categories that are used in natural language about landscape as well as other means of conveying geographic information.

Key messages Sketch mapping

- Sketch maps are people's hand-drawn representations of elements in space and their relation to each other
- Sketch maps have been used to study indigenous conceptualisations of space, but some forms of knowledge may not be easily represented on maps.

PGIS applications and challenges. One of the most prominent uses of PGIS and participatory mapping is in natural resource management, ranging from mapping resource distribution and use (Ahamed et al. 2009; Bernard, Barbosa, and Carvalho 2011), to community-based decision making about resource management (Cronkleton et al. 2010; Jankowski 2009), monitoring progress towards environmental management goals (Fraser et al. 2006; Mapedza, Wright, and Fawcett 2003), and mapping indigenous resource use and occupancy (Chapin, Lamb, and Threlkeld 2005; Tobias 2009; Turk and Mackaness 1995). Despite the growing popularity and some success stories of PGIS and participatory mapping (e.g. McCall 2003), several challenges and unintended consequences also became apparent (Elwood 2006; Kwaku Kyem 2004).

In many PGIS projects, it was difficult to bridge the technological gap between local users for whom a PGIS was being designed, and those who implemented the technology, such as scientists or technicians (Jankowski 2009; Wellen and Sieber 2013). This technological gap is difficult to bridge and may result in projects that had been designed as participatory approaches, but in practice, local people merely served as a data source, without being empowered to participate in the process of analysing and using these data for decision-making.

In some cases, rather than empowering marginalised groups, PGIS projects ironically cemented existing power structures and disempowered local communities (Chapin, Lamb, and Threlkeld 2005). In community mapping projects in Tanzania and Thailand, for example, the use of GIS technology in a PGIS project prescribed formal boundaries for representing informal, overlapping use rights. In turn, this facilitated the introduction of state-sanctioned private land tenure at the expense of local people's customary land rights (Hodgson and Schroeder 2002; Roth 2007).

Another challenge was that although PGIS approaches have been used to resolve conflicts (Brown and Raymond 2014; Cronkleton et al. 2010; McCall 2003), some PGIS projects may have unintentionally caused conflicts (Carton and Thissen 2009). To investigate the potential for conflicts resulting from participatory mapping, a study in the Bolivian Amazon conducted standardised random mapping experiments in 17 villages, finding no statistical increase in conflicts (Reyes-García et al. 2012). However, the mapping exercises in this study were not linked to any decision-making and planning, which considerably lowers the stakes at hand and therefore also the potential for conflicts. The findings by Reyes-García et al. (2012) thus mainly highlight that the social context influences the potential for conflicts that can arise from participatory mapping and PGIS projects. As a consequence, before conducting participatory mapping projects, researchers and practitioners should carefully consider social context where they will conduct a PGIS study or implement a PGIS project.

Key messages PGIS applications and challenges

- One of the most prominent examples of PGIS applications is in natural resource management
- A challenge of many PGIS approaches is to bridge the gap between the users of a PGIS and those who developed it
- PGIS projects may cause conflicts in local communities, but the potential for such conflicts may be highly dependent on the social context in which participatory mapping is conducted

2.3.4. Qualitative GIS approaches and local knowledge

Although GIS had long been established as a technology and associated methods to handle quantitative data, researchers also started to explore the potential of GIS to engage with more qualitative forms of knowledge (Kwan and Knigge 2006; Pavlovskaya 2006). This strand of GIS became known as 'qualitative GIS' (Cope and Elwood 2009). Qualitative GIS integrate multiple forms of data such as pictures, sketches, interviews, videos and other ethnographic material into GIS.

A range of studies demonstrated the breadth of qualitative GIS applications. For example, researchers investigating social welfare provisioning to low-income families in three US-cities used qualitative GIS to contextualise family ethnographies with geographic data (Matthews, Detwiler, and Burton 2005). Another example is a study from New York, where the combination of geographic visualisations and grounded theory brought to light the importance of community gardens (Knigge and Cope 2006). Feminist geographers also engaged with qualitative GIS approaches (Kwan 2002a), for instance, analysing urban change and its link to the household level in post-Soviet Moscow (Pavlovskaya 2002), or mapping women's perception of public spaces in Teheran (Bagheri 2014).

Qualitative GIS approaches demonstrated how the perceived incompatibility of critical (feminist) research and GIS could be bridged, and that qualitative, non-positivistic engagements with

GIS were indeed possible (Kwan 2002a; Kwan 2002b; Jung and Elwood 2010; Cope and Elwood 2009). However, qualitative GIS approaches commonly relied on the use of fairly standard GIS applications and programs. These studies, with few exceptions (e.g. Leszczynski 2009) therefore seldom questioned the quantitative limitations posed by the current implementations of GIS on the forms that such qualitative information can take.

Studies using the label of qualitative GIS have mostly focused on the perspective of non-dominant or marginalised groups in Western cultural contexts. Applying GIS, whether qualitative or not, to other cultural contexts poses an additional set of challenges. Rundstrom (1995), for example, criticised GIS for their lack of attention to epistemological questions. He cautioned that an uncritical use of GIS to document local knowledge outside the Western scientific epistemological framework may transform this knowledge to fit existing cartographic conventions. Rundstrom stated that GIS were:

[…] toxic to human diversity, notably the diversity of systems for knowing about the world.

(Rundstrom 1995, p. 45)

Such fundamental critiques notwithstanding, standard GIS have become widely distributed to indigenous communities. In some cases, these standard GIS approaches were combined with qualitative data for documenting indigenous knowledge. Examples range from documenting and representing local knowledge on harvesting or hunting sites (Gearheard et al. 2011; Tobias 2009) (Tobias 2009; Gearheard et al. 2011), to including stories and songs in an online indigenous atlas (Caquard et al. 2009), to incorporating pictures and simulated horizons on maps (Aporta and Higgs 2005), and producing a web-based GIS for the use of communities in Arctic Alaska (Eisner et al. 2012). In most of these studies, standard GIS formed the basis, and local knowledge was

added onto standard cartographic representations in the form of different types of qualitative information. However, several aspects of local knowledge may still be difficult or impossible to represent in standard GIS, because they challenge the epistemological framework underlying current GIS implementations. Examples include contextualised geographic information transmitted through storytelling, singing, and other performative acts embedded in the social context and experience on the land (Johnson 2010a).

These critiques of qualitative GIS and its limitations relate to more fundamental epistemological and ontological questions linked to the production of geographic knowledge through GIS. In the next section, I describe how such questions have been addressed in ontology research in information science and GIScience.

Key messages Qualitative GIS

- The goal of qualitative GIS is to integrate different types of knowledge into GIS in the form of qualitative data such as pictures, drawings, ethnographic accounts, songs, or videos
- Qualitative GIS approaches often relied on using standard GIS software and adding qualitative information onto standard geographic representations

2.3.5. Ontology research

Critiques on GIS enabled a debate not only about the uses and implications of GIS, but also about possible reconstructions and re-inventions of GIS (Sieber 2004). GIScientists emphasised that for critiques of GIS to be taken up within the GIScience research community they must consider requirements of the coding environment, where knowledge about real-world phenomena is abstracted and expressed in (formal) ontologies (Schuurman and Leszczynski 2006). Ontology research therefore has the potential of bridging the gap between critiques of GIS and actual GIS technology and implementation. As Kitchin et al. stated about mapping (and by extension, GIS):

Mapping is epistemological but also deeply ontological – it is both a way of thinking about the world, offering a framework for knowledge, and a set of assertions about the world itself.

(Kitchin, Perkins, and Dodge 2011, p.1)

While epistemology is basically *how* we know about the world, ontology is *what* we know (Leszczynski 2009). In the philosophical tradition, ontology is seen as the essence of a phenomenon or an object. Ontology research is therefore the study of the existence of all kinds of entities and phenomena, abstract or concrete, which make up the world (Agarwal 2005). Contrastingly, in information science and in GIS, where code becomes important, ontology is understood as a specification of a certain conceptualisation through a system of concepts and categories (Gruber 1993; Schuurman and Leszczynski 2006; Smith and Mark 2001). In formal classifications, categories define the entities that exist, or that may exist, and that form the basis for representations in GIS (Kuhn 2001; Schuurman and Leszczynski 2006). Ontologies are important for GIScience because they:

can help us to understand how different groups of people exchange (or fail to exchange) geographical information, both when communicating with each other and also when communicating with computers.

(Smith and Mark 2001, p. 592)

Researchers in information science identified issues associated with different ontologies in different communities of practice, and the failure of categories to move back and forth between such communities (Bowker and Star 2000; Harvey et al. 1999). As a GIS is constituted by its data models that are in turn rooted in

different ontological perspectives of space, ontologies provide a possibility to integrate multiple ways of looking at the world, both conceptually, and in computational environments. Thus, GIS are potentially suited to integrate different ontologies of the geographic domain, which are each based in different epistemologies or ways of knowing about the world.

However, for too long, GIS have been firmly rooted in a Western scientific epistemological framework that adopted scientific categories (e.g. ESRI 2015; Feranec et al. 2010; Mücher et al. 2010). Typically, scientists, including ontology engineers who knew about formal axiomatisations, and domain experts developed ontologies in a top-down manner, for example in so called 'GeoVoCamps' (Hitzler, Janowicz, and Krisnadhi 2015).

If we acknowledge the possibility of the co-existence of multiple ontologies, this brings up the question of 'where to take the ontology from' when developing a GIS. Rather than developing ontologies in a top-down manner, another approach is to use folk categories elicited through ethnographic methods (e.g. Mark and Turk 2003; Turk et al. 2011) as a basis for ontology development for GIS (Wellen and Sieber 2013). The process of building a GIS from the bottom up based on folk categories is challenging, and only few researchers have attempted it. Wellen and Sieber (2013) built a GIS based on a folk ontology of Cree hydrographic features. According to the researchers' own critical view, the developed GIS fell short of its goals, because of the technological gap between the people who had to use it and those who developed it (Wellen and Sieber 2013). Furthermore, although this GIS used the Cree folk ontologies as a basis, the interface was not particularly designed for easy usability by Cree participants. This highlights the challenge of overcoming technical barriers when implementing a GIS based on folk ontologies.

Key messages Ontology research

- Epistemology is how we know the world, ontology is what we know about it
- The understanding of ontology in philosophy is the essence of being, while in the information sciences, it is a specification of a certain conceptualisation through concepts and categories
- Ontologies are the basis for GIS, as they define what can be represented
- Ontologies for GIS have often been designed in a top-down manner by a group of experts
- In order to improve the interactions between GIS and users, folk geographic categories may be used for developing a domain ontology

2.4. Research gaps and specific research questions

Based on the overview of existing work on aspects of categorisation, landscape and GIScience of relevance for this thesis, I now set out research gaps in the literature as the basis for the specific research questions that together aim to contribute to the overarching question:

- **How can local landscape categorisations be accessed and represented?**

2.4.1 Research question 1 on the institutional setting in the study area

Different institutions may use different definitions of landscape categories and associated meanings, which has real-world implications for how landscapes are managed (Robbins 2001). Landscape categorisations should therefore not be seen as detached concepts, but as categories and associated semantics that are embedded in specific institutional contexts. However, as most studies on landscape terms focused on documenting vocabularies or studying the grammatical encoding of landscape in a particular landscape, such political ecological questions were typically not considered relevant or are not taken into account. There is thus a gap in linking work on landscape categories with the context in which this categorisation is embedded. Therefore, as a basis for this thesis, it is necessary to investigate the institutions involved in the management of natural resources and the socio-economic context in which these institutions are situated. The attention to context is particularly important for research involving maps and GIS, because information portrayed in such a manner acts on reality, rather than merely representing it in a value-neutral way (Crampton 2001; Pickles 1995). Participatory GIS projects and research that neglect the importance of context may result in unintended, negative outcomes, including conflicts between different actors involved (e.g. Carton and Thissen 2009; Chapin, Lamb, and Threlkeld 2005; Hodgson and Schroeder 2002; Roth 2007). The first research question addresses the institutions in the study area and the different actors involved in landscape and natural resource management:

Specific research question 1: *What is the current institutional setting for natural resource management?(RQ1)*

2.4.2 Research question 2 on folk landscape categorisation

While much work has been conducted on folk categorisations in the biological domain, relatively little research addressed geographic categorisations. Researchers investigated geographic categories in English, Portuguese and Greek in controlled experiments with undergraduate students in lab-like settings (Pires 2005; Giannakopoulou et al. 2013; Mark, Smith, and Tversky 1999). However, to access commonsense geographic categorisations of a broader public and of groups from different cultural backgrounds, more ethnographic approaches are needed.

Research in different fields such as linguistics, geography, ethnophysiography, and landscape ethnoecology has investigated folk categorisations of landscape of different groups. While such studies have often focused on endangered languages with few speakers, little research explored folk landscape categorisations of indigenous people speaking a non-endangered indigenous language or a majority language.

Furthermore, research in landscape ethnoecology highlighted the importance of taking into account how people interact with landscape in a cultural context, as well as paying attention to the biophysical underpinnings of the identified folk landscape units. However, landscape concepts in majority languages spoken by indigenous peoples remain under investigated. In linguistic studies, the underlying referents and their cultural and ecological significance were not often taken into account, despite their importance for improving our understanding of how people interact with and relate to their environment. Furthermore, the way in which scientists and people living in a landscape differ in the way they categorise this landscape has rarely been investigated (e.g. Hunn 1975), although such differences can have direct implications for how landscapes are being managed (e.g. Hoeschele 2000; Robbins 2001).

Specific research question 2: *What categories are culturally recognised in a landscape folk categorisation and what are their ecological underpinnings and cultural significance? (RQ2)*

2.4.3 Research question 3 on the organisation of folk landscape categories

Based on the folk landscape categories explored in RQ2, a further question is how people organise these categories in their knowledge system. In fields such as botany and zoology, ethnographic approaches were commonly used to study the organisational principles of folk categorisations (e.g. Berlin 1992). However, the study of hierarchies of folk categorisations of the geographic domain received little attention (but see Duvall 2008 for physical features and Furbee 1989 for soil classification). Researchers applied Rosch's (1978) elicitation methods in experiments on the hierarchy of geographic categories (e.g. Lloyd et al. 1996; Tversky & Hemenway 1983), but these studies did not provide a taxonomy of the geographic domain. Some of the results in these studies represent instances of geographic features rather than categories at different hierarchies (e.g. Lloyd et al. 1996). Furthermore, whether the strict principles postulated in theories on hierarchical organisation of folk biological categories are applicable to the landscape domain remains questionable.

Moreover, although two categorisation systems may resemble each other, the reasons underlying a hierarchy and a conceptualisation of the landscape domain may differ. It is thus essential not only to document folk landscape categories and how they are organised, but also what drives this categorisation.

Ethnobiological and ethnozoological studies found that often morphological (shape, size), ecological (habitats) and utilitarian factors (local uses) shaped hierarchical organisation (Posey 1984; López et al. 1997; Medin et al. 2006; Boster and Johnson 1989). However, these studies mostly relied on consultants sorting labelled cards, which in some experiments led consultants to group lexically similar cards together (López et al. 1997). In intercultural settings and with unequal literacy levels between consultants, the sorting of labelled cards is not a suitable method, and more visual prompts such as pictures should therefore be tested.

For the geographic domain, the few studies that addressed drivers for geographic categorization reported similar criteria as the folk biological studies (Duvall 2008; Williams, Kuhn, and Painho 2012). However, an important aspect that has so far been neglected is the specificity of the geographic domain influencing categorisation. Geographic features such as mountains, rivers or pine forests do not have clear boundaries, unlike most biological organisms. Furthermore, geographic features are typically attached to the Earth's surface and rarely change their arrangement in space with respect to each other (although of course rivers and glaciers flow, forests advance or retreat and sand dunes move etc.). The spatial arrangement or the topology of geographic features in the actual landscape may therefore also influence category organisation. The perceptual scale of *environmental space* (Montello 1993) differs considerably from other perceptual scales such as table-top space that can be perceived within one's field of vision, and where objects are typically small and movable. Such differences may influence how people organise knowledge about the geographic domain. However, the influence of these particularities of the geographic domain on category organisation has not been investigated.

Specific research question 3: *How is a folk categorisation of landscape organised and what are the drivers for landscape categorisation? (RQ3)*

2.4.4 Research question 4 on categorisations of the same environment in different languages

Work in landscape ethnoecology and ethnophysiography has shown considerable variation in how people categorise landscapes (Mark et al. 2011a; Johnson and Hunn 2010). Different factors were shown to influence folk geographic categorisation, such as the actual landscape, language and culture (Holton 2011; Johnson 2011). Some comparative studies relied on comparisons of folk categorisations from people living in geographically distinct areas (the Amazon and Asian rainforests, for instance), but these landscapes were judged as 'similar' by the researchers conducting the study (Ellen 2010). Such comparisons are thus fraught with uncertainties about whether these environments are comparable at all. Few studies looked at categorisation of different groups living in the same physical environment, most of them for the boreal North, such as, Holton (2011) and Johnson (2011).

Specific research question 4: *How does the categorisation of the same landscape differ between different groups of people? (RQ4)*

2.4.5 Research question 5 on representing folk landscape categories on maps and in GIS

GIS were criticised for their focus on quantitative methods and data that fail to take into account geographic conceptualisations of a broader public. Research strands such as qualitative GIS and participatory GIS addressed some of these critiques (Cope and Elwood 2009). Although a range of participatory and qualitative GIS projects illustrated the potentials of such approaches, the use of GIS in cross-cultural settings remains challenging and was criticised for being problematic from the point of view of indigenous peoples, because GIS impose Western-scientific epistemologies and ontologies (Rundstrom 1995). Concerns and critiques notwithstanding, GIS became widespread across the world for the collection, analysis and visualisation of spatial data for decision-making in landscape management and spatial planning. Given the necessity to participate in negotiations with local and national governmental agencies, many indigenous groups have adopted GIS. Thus, for many indigenous peoples completely rejecting GIS technology because it is 'toxic to the diversity of knowing' (Rundstrom 1995) is not a viable option. Rather, avenues have to be explored in which local understandings of landscape can be better integrated into the technological framework of GIS.

Specific research question 5: *How can local understandings of landscape be represented on maps and in a computational environment? (RQ5)*

Based on RQ5, I further identify two sub-questions to be answered in this thesis that deal with sketch mapping and computational representations:

Many participatory mapping approaches that set out to document local understandings of space used pre-defined topographic maps as a basis, which may impose standard cartographic maps on people's own understandings of space. Sketch maps by contrast are free drawings, and may serve as an alternative mapping method to explore people's conceptualisations. While sketch maps have been commonly used in behavioural geography and psychological research, within GIScience, sketch maps have received less attention in participatory GIS, although they offer rich information, both in terms of *what* is mapped (the geographic features or categories that are depicted) and *how* these features are mapped (perspective, arrangement, use of abstraction). Sketch maps thus allow insights into how people think about and remember their surroundings, which can form the basis for developing more user-friendly GIS.

Specific research question 5.1: *What geographic features do people draw on sketch maps and how do they represent them? (RQ 5.1)*

As the foundation of formal representations in GIS, ontologies, including categories, are crucial building blocks for information systems as ways in which geographic knowledge is structured. When building a GIS, the common approach was often to adopt Western scientific classifications. However, more bottom-up, so-called 'folk categorisations' of the geographic domain were documented through ethnographic work that better represent how people conceptualise space may also be used (Mark and Turk 2003; Turk et al. 2011). Moreover, people's sense of place (Basso 1996; Cresswell 2006) is not well representable in standard GIS, but more qualitative GIS have been developed that can handle a range of qualitative information such as pictures, texts, or audio recordings to better convey people's understanding of place (Auld and Kershaw 2005; Cope and Elwood 2009; Knigge and Cope 2006). Despite the potential of combining ethnographic approaches for generating more bottom-up folk ontologies with qualitative GIS to develop more culturally-appropriate representations of space (and place), very little work has been conducted

in this area (e.g. Wellen and Sieber 2013 on developing folk ontologies as the basis for a community GIS).

Specific research question 5.2: *How can we better represent local notions of landscape in a computational environment? (RQ 5.2)*

2.4.6 Summary of specific research questions and methods used

The following table (Tab.1) summarises the specific research questions introduced above and for each question indicates the methods used, which are explained in more detail in Chapter 4.

Tab. 1 Specific research questions and respective methods

	Research question	Methods
RQ1	*What is the current institutional setting for natural resource management?*	· Literature review including historical records and GO reports · Participatory observation · Semi-structured interviews
RQ2	*What categories are culturally recognised in a landscape folk categorisation and what are their ecological underpinnings and cultural significance?*	· Participatory observation · Field walks · Semi-structured interviews on landscape photographs
RQ3	*How is a folk categorisation of landscape organised and what are the drivers for landscape categorisation?*	· Sorting exercises with landscape photographs · Interviews after sorting exercise

RQ4	*How does the categorisation of the same landscape differ between different groups of people?*	· Interviews with landscape photographs with Takana and Mosetén consultants · Annotation of landscape terms by local language experts
RQ5	*How can local understandings of landscape be represented on maps and in a computational environment?*	· Sketch mapping exercises · Participatory observation of GIS use in the study area · Adaptation of a mapping platform for local needs · Evaluation of the platform

The rainforest is everything to us.
It gives us what we need to live.
Takana consultant, 2012

Chapter 3
Institutional pluralism for natural resource management in the study area

This chapter presents results from original empirical and literature research addressing *RQ1* on the current institutional setting for natural resource management in the study area.
The study area was located in northwestern Bolivia (Fig. 4) at the foothills of the Andes, where the Cordillera Oriental meets the lowland alluvial plains, and altitudes above sea level range between 200 to 600 m.

Fig. 4 Location of the study area in north-western Bolivia

[3] Part of this chapter is based on the following publication:
Wartmann, F.M.; Haller, T.; Backhaus N. (2016): 'Institutional Shopping' for Natural Resource Management in a Protected Area and Indigenous Territory in the Bolivian Amazon. Human Organisation 75 (3): 218-229.

The climate is tropical, with a mean annual temperature of 25° C, mean annual rainfall of 1927mm, a rainy season between October and February and a dry season between May and August (SERNAP 2013). The vegetation in the study area largely consists of rainforest and pioneer riverside vegetation in seasonally flooded areas (Fuentes 2005, Fig. 5). The study area is situated in a region that, because of its high species diversity, was claimed to be a biodiversity hotspot of global importance (Mittermeier et al. 1998; Painter, Wallace, and Gómez 2006; Spector 2002).

Fig. 5 Study area along the Tuichi River

In the following, I introduce the institutional setting in the study area. The material presented in this chapter is based on a the combination of reviewing written sources such as historical accounts and NGO reports, and conducting interviews with 17 consultants on oral history and the current institutional situation for natural resource management in the study area.

3.1. History of the study area

In Incan times, the region along the Beni river had been an area of economic exchange, with the Incas establishing several trails linking the Amazonian lowlands to Cusco to facilitate access to natural resources such as vanilla, cacao, precious woods and bird feathers (Combès 2012). In search of the legendary El Dorado, the first Spanish military expeditions entered what today is known as the Madidi area in 1536. Almost simultaneously, Franciscan missionaries started establishing settlements to convert the different nomadic indigenous groups to sedentary small-scale agriculturalists paying tribute to the Spanish crown. Due to the severe impacts of colonisation on indigenous health and lifestyles, several indigenous groups disappeared completely, while others coalesced, emerging with new cultural identities, such as the Takana (Silva et al. 2002).

After the creation of the republic in 1825, the political discourse portrayed the Bolivian north as 'empty land' in need of economic development. This marked the beginning of different successive booms of commercial resource extraction. The first boom was the extraction of quinine bark (*Cinchona officinalis*) used in malaria treatment, which lasted until 1880 (Salinas 2007). A rubber boom followed up until 1912, with drastic consequences for indigenous peoples who were, sometimes forcefully, recruited to collect rubber under slave-like conditions (Córdoba 2012; Silva et al. 2002). As the local population could not meet the demands of the growing rubber industry, labourers from other regions in Bolivia and neighbouring countries migrated to the area. To meet the needs of this increasing population, large ranches and areas for intensive agricultural production were established, further decreasing the land available to indigenous peoples. The Agrarian Reform in 1953 sought to remedy the imbalance caused by large land ownership concentrated in the hands of a few. The era of the *haciendas* (ranches) lasted until the 1960s, when the Agrarian Reform started to be implemented in the lowlands. However,

the reform did not manage to fulfill its social goals, as in practice few indigenous peoples obtained individual property rights.
In the 1960s, increasing demand from global markets led to a boom on animal fur land hives, attracting hunters from other areas to enter the Madidi region for the profits to be made. Species such as the caiman, white-lipped peccary, giant otter and jaguar were hunted so intensively that these animal populations declined severely. Local hunters participated as well, as the Takana hunter Leonardo remembers:

They killed the chanchos [white-lipped peccaries] only for the leather, it was too much meat to eat; they left it for the vultures to eat. They sold the skin. That was what people did in those days. They hunted the animals to sell their skins.

In the 1970s, external factors changed as the government started a development policy that included a massive colonisation campaign, resulting in the immigration of mostly Aymara and Quechua people from the Bolivian highland (Painter 2007). As part of this policy, large forestry concessions were handed out to logging companies (Lehm 2012). With the road network expansion that connected the town of Rurrenabaque to La Paz in the late 1980s, transportation costs decreased drastically. Technological developments such as the advent of chainsaws instead of manual saws further increased the speed at which timber could be extracted. The preferred species were big-leaf mahogany (*Swietenia macrophylla*) and South American oak (*Amburana cearensis*). Once the precious wood from the most accessible areas was exhausted, other giant trees including *Ficus* spp. were harvested. Timber extraction quickly became the main source of income for the local population, both for Takana people and settlers from the highlands. Joaquín remembers that many Takana families were living from logging, including his own:

The majority of families went to fell trees, the very old trees, and over 10 of those each day. When you went to the forest you would see how the forest was changing with all those trees being felled. Everybody who was able to fell trees was felling trees. The river was full of floats loaded with timber. Every day they were floating the timber down the river [to Rurrenabaque].

Eventually, the visible effects of environmental degradation brought about by intensive resource extraction called international actors, especially NGOs, into action in attempts to protect the biodiversity-rich Madidi area.

Key messages History of study area

- Spanish colonisation of the Madidi area started in 1536 with Spanish military expeditions and later Franciscan missionary activities, often with dramatic detrimental impacts for indigenous people
- After the creation of the Bolivian Republic in 1825, commercial resource extraction in the Bolivian lowland started, leading to different extractive booms and rapid socio-economic and ecological changes

3.2. Madidi protected area

In response to the massive deforestation and environmental degradation, the Madidi protected area was established in 1995 through a Supreme Decree (N° 24123, 1995) with the goals of conserving biodiversity, landscapes, archaeological sites, indigenous systems of resource use and promoting ecotourism activities. The protected area is divided into two management categories. The first is a national park ('Parque Nacional' or PN) that covers 12,715 km^2. The objective of the Madidi National Park is the strict protection of a representative sample of ecosystems, biogeographic regions and the faunistic and floral resources, geomorphologic, scenic and landscape values they may contain. In this category, the extraction and consumption of natural resources is prohibited, except for scientific research, ecotourism, environmental education and subsistence activities of indigenous peoples ('pueblos originarios'), provided that extractive activities have been authorised according to the specific zonification, management plans and regulatory norms of the protected area set forth by the national park management authorities of the 'Servicio Nacional de Areas Protegidas' (SERNAP). The second category is a natural area of integrated management ('Área Natural de Manejo Integrado' or ANMI) that covers 6,242 km2, with the objective of making compatible the conservation of biological diversity with the sustainable development of the local population. The Bolivian constitution recognises that the integrated management area consists of a mosaic of units including species communities of fauna and flora, zones of traditional systems for land use, zones for multiple resource use, and zones for strict protection (Art. 25, D.S. N° 24781, 31.07.1997).

Data source:
Servicio Nacional de Áreas Protegidas - SERNAP 2002
and Protected Area Network 2015
Available on http://www.protectedplanet.net

Fig. 6 Overview of Madidi National Park (PN) and Integrated Management Area (ANMI), with neighbouring protected areas

The Madidi National Park and Natural Area of Integrated Management form the Madidi protected area that covers a total of 18,957 km^2, which is roughly half the size of Switzerland. It borders the protected areas of Pilón Lajas in the East and Apolobamba in the South. Towards the Northwest, it borders the Peruvian protected areas of Bahuaja Sonene and Tambopata, forming a large protected area network (Fig. 6).

Currently, around 3,600 people of different groups, namely Takana, Mosetén, Ese Ejja, Quechua and peasant farmers live in 33 communities within the protected area, administered by SERNAP with a local office in San Buenaventura. The Madidi protected area staff consists of a director, a conservation officer and two administration staff working at the local office and thirty park guards who are stationed in rotation at thirteen different control posts.

In its early years (around 1995 to 2000), international NGOs such as Conservation International and Wildlife Conservation Society were instrumental in the set-up and implementation of the Madidi protected area. A management committee was supposed to ensure the participation of different stakeholders, with members ranging from local municipalities, indigenous organisations (including CIPTA) to international NGOs (Lehm et al. 2002). Despite this set-up, in practice, the establishment of the protected area was less participatory, which created tensions with local users.

One key issue was residency and formal land tenure of indigenous peoples. With the creation of the protected area, all land contained within the newly created borders became state property. Indigenous people who could prove their history of occupation, for instance, through formal land titles provided by the 'Instituto Nacional de Reforma Agraria' (INRA) during the implementation of the Bolivian Agrarian Reform from 1952 were able to maintain residency. However, not all people living within the area that became a protected area were registered as residents. Some had lost the paperwork for their land title deeds, while others living in dispersed family units within the forest (a common settlement pattern for the Takana) were never contacted during the registration process. Becoming registered as residents at a later point involved a lengthy legal process. Guillermo, member of a Takana family who lived in an area that became protected said:

The major problem was that we didn't show up on the map. My family continued to live there and they had to go through a whole lot of formal channels to get their rights to the land recognised.

As a consequence, several families abandoned their homes in the protected area. Others had left in search for work or to school their children in Rurrenabaque and were then unable to return. Marcela, a Takana woman who lived where there is now park, was upset about this:

I was born and raised in this area where there is park now. Only because we left for some years [to Rurrenabaque] we are not allowed to go back now. They won't even let us in for a visit. I think that people who have been born there shouldn't be excluded like that.

Another issue was the introduction of formal regulations for resource use and their enforcement through protected area staff. On paper, the regulations of the protected area guaranteed residents the right for subsistence use of natural resources in the integrated management area. Hunting and consuming meat of species such as the spotted paca (*Cuniculus paca*, a large rodent) would therefore have been legal. However, in the first years after the creation of the protected area, park guards confiscated all fish and game consultants were carrying, as well as equipment

such as boats, fishing nets and hunting rifles. Aurelio, a Takana hunter remembered an encounter with park guards:

When I had a 'jochi' [spotted paca] of 3 to 4 kilos with me they [the park guards] took it away and told me that it was forbidden to hunt. I told them that it was for me and my family to eat, and still they took it from me.

Actual management practices by field staff were thus more restrictive than the formal rules, resulting in a fortress-like conservation approach (Brockington 2002). After the establishment of the protected area, indigenous people were excluded from accessing natural resources in the protected area, despite existing formal legislation guaranteeing subsistence use rights for residents. These (overly) restrictive management practices of park guards have since changed. Park guards received trainings in the application of national park regulations and were sensitised in communication with local communities. Today, consultants living within the protected area express a predominantly positive attitude. For example, Aurelio stated:

So the park came and the park is not at all bad. The park doesn't harass anyone; it even helps to protect the place. The park is an institution that doesn't harass, the park doesn't hunt, the park doesn't fish, and it doesn't cut a single tree. The park isn't bad, the park is good.

However, this institutional setting changed when the Takana indigenous territory was created in 2003.

Key messages Madidi protected area

- As a reaction to the large-scale commercial resource extraction and related detrimental environmental effects, the Bolivian government established the Madidi protected area in 1995 International NGOs were instrumental in the set-up of the protected area
- The introduction of new formal regulations for resource use within the protected area created tensions with residents who wanted to continue using resources for commercial and subsistence purposes

3.3. Takana Indigenous Territory

As a response to the ongoing loss of their traditionally inhabited lands since the early 1990s for the establishment of cattle ranches, forestry concessions and for agricultural production, the Takana, together with other Amazonian indigenous peoples, participated in the March for Territory and Dignity to La Paz in 1990 to voice their demands for the recognition of indigenous rights (CIPTA 2010). These widespread demands were eventually taken up in legislation, with the Constitution of 1994 (Article 171) providing the foundation for the creation of indigenous territories. As the Agrarian reform of 1953 did not achieve its goals in the Bolivian lowlands, a revised law was put in place in 1996: the Law of the National Service of the Agrarian Reform (Law 1715). This law lists six categories for agrarian property in Bolivia, one of which is the so-called 'Tierra Comunitaria de Origen' (indigenous territory) abbreviated as TCO. Article 41 specifies:

The 'Tierras Comunitarias de Origen' are the geographic spaces that constitute the habitat of indigenous communities and peoples, to which they traditionally have had access and where they maintain and develop their own forms of economic, social and cultural organisation to assure their survival and development. They are inalienable, indivisible, irreversible, collective, composed of communities or unions, unseizable, and exempt from the statute of limitations.

(Bolivian Republic 1996, own translation)

The Takana Council (Consejo Indígena del Pueblo Takana, CIPTA), put in a demand for a TCO, and in 2003 was granted a title over 370,000 ha. The TCO Takana partially overlaps with the Madidi Integrated Management Area in the study area (Fig. 7).

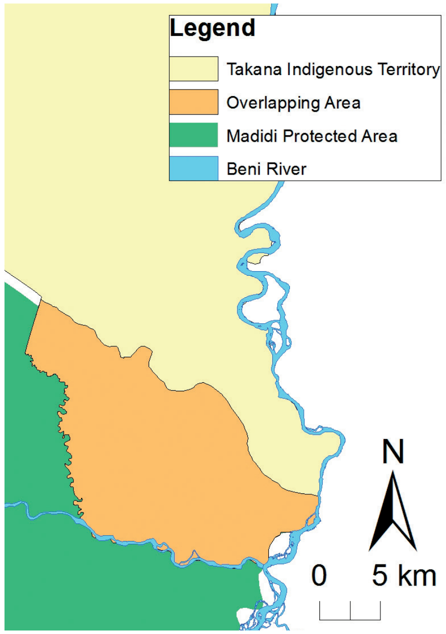

Fig. 7 The overlap of the Madidi protected area and the TCO Takana

The establishment of the indigenous territory introduced another set of formal institutions in addition to the regulations for the Madidi protected area. This created tensions, because Takana people living in individual family units in the overlap area and Takana people living in communities such as San Miguel del Bala and Villa Alcira in the indigenous territory outside the protected area claim use rights to resources in the overlapping area (Fig. 7). In view of the two co-existing formal institutions, the different user groups strategically refer to the institutional framework that lends legitimacy to their claims. On the one hand, indigenous people living in the overlap area refer to the regulations of the protected area that exclude other users who are not residents of the protected area, irrespective whether they are indigenous people or not. Magdalena who lives in this overlap zone emphasised:

Now I agree with the park, because now they recognised us as residents. But there are many people who are against the park, who want to go hunting and fishing, and now there is the park. Thanks to the park I say because if it wasn't for the park, people would come here to hunt. Now it is forbidden to hunt by those from outside.

On the other hand, people living in the indigenous territory outside the protected area refer to their rights as Takana indigenous people and residents of the TCO Takana. For example, Enrico who lives in a community outside the protected area sometimes goes to hunt in the overlap zone. He knows about protected area regulations but said:

Within a TCO there are no borders. All the land belongs to all of us.

The overlapping claims to use resources within the same spatial extent leads to conflict between these user groups. Ignacio who lives in the protected area remarked:

There are the park regulations. But still they come from the community. They come to cut trees and hunt. When I ask them what they are doing here they say: "we are TCO". I'm not saying they are not lowland indigenous people, but according to the formal regulations it's illegal what they do.

Ignacio's statement illustrates how residents of the TCO Takana living outside the protected area legitimise their use of resources within the park by claiming use rights as residents of the TCO. However, referring to formal regulations of the protected area does not always increase the bargaining power of indigenous peoples living in the overlapping area, because park management staff with limited resources are often absent and not enforcing park regulations. Therefore, Takana indigenous people living inside the protected area also use a discourse on their indigenousness as *originarios* ('local' indigenous people of the lowlands) and family history to exclude other competing users, such as peasants from the highlands and other community members from the TCO Takana.

Because of institutional pluralism, another issue arose. Protected area regulations allow subsistence use by residents of the protected area. Communal organisations of TCOs however are able to commercially extract resources according to defined management plans. Residents of the TCO claim commercial use rights for overlapping areas, but park management staff takes measures against such resource extraction. Park guard José said:

We have intervened and confiscated their equipment, but they come back, saying they are within their rights as indigenous people. We can't start pressing charges, because it is not politically convenient.

In the context of natural resource management in the protected area and the Takana indigenous territory, the use of mapping and GIS has become important. The international NGO 'Wildlife Conservation Society' (WCS) conducted participatory rural assessments ('Diagnostico Rural Participativo') in collaboration with CIPTA (Lehm and Chavez 2001). For the village of Villa Alcira, where the participatory rural assessment took place during four consecutive days in the year 2000, the internal project report of

WCS and CIPTA mentions participatory mapping as a method, but without stating any details of how the mapping was conducted, who participated, and what was mapped. The report describes local use areas for hunting, fishing, and agriculture, also using some local terminology for use areas. However, despite a permit for accessing the WCS archives in La Paz, I was unable to locate any map produced during the participatory mapping in the year 2000. The written report states that a little more than half of the communal area consisted of rainforest, where people go hunting and collect plant material, and the rest consisted of areas for housing and agricultural areas (Lehm and Chavez 2001). Although the details of the mapping process may remain unclear, the participatory mapping documented the simmering territorial conflicts between the protected area and adjacent indigenous communities, as well as between indigenous communities. Contestations revolve around the use of hunting and fishing areas, as well as important plant harvesting sites.

As the participatory rural diagnostics served as the basis for management plans of the TCO Takana, some of the information of the participatory mapping results eventually was incorporated into the GIS (ArcGIS) used by the Takana council for land management. Consultants who reside in the overlapping zone of protected area and TCO criticised that the sketch maps from the community were digitised and used for management without checking their validity in the field. For instance, several residents stated that the communal hunting area of the TCO Takana now overlaps with their own hunting area within the protected area. The maps drawn in the participatory mapping therefore do not simply reflect use areas, but claims to use areas that are contested by other user groups. However, through the representation of participatory mapping results in a GIS, place-based knowledge of one user group became de-contextualised authoritative information used as the basis for management decisions in the TCO.

Key messages Takana indigenous territory

- The Takana Council (CIPTA) was granted a communal land title of the TCO Takana in 2003
- The TCO Takana partially overlaps with the Madidi protected area, creating institutional pluralism where different, and sometimes competing institutions for the management of natural resources co-exist
- In this context, maps and GIS are important for the management of natural resources, because they represent certain views and claims that become the basis for management decisions

3.4 Justification for the choice of study site

The study site in the Bolivian Amazon is located in an overlapping area between an indigenous territory managed by an indigenous council and a protected area managed by the national park authorities. These two institutions have jurisdiction over the same geographic area, providing an ideal setting to explore how different groups of people based in different epistemological frameworks categorise the same bio-physical environment, and the implications these categorisations have for spatial representations on maps and in GIS. The study site is thus ideal to explore landscape categorisation both from a more theoretical standpoint and to link this research back to practical and societally relevant management questions.

If we knew what it was
we were doing, it would not be
called research, would it?
Albert Einstein, quoted in Paul Hawken et al.:
Natural Capitalism, 1999: p. 272

Chapter 4
Methodology for eliciting and representing folk landscape categories

To collect data, I conducted field work in the Bolivian Amazon during eight months, from July 2012 to September 2012, January 2013, June to August 2013 and in August 2015. I used a combination of methods informed by social anthropology and linguistics to answer the specific research questions. Figure 8 presents an overview of the methodological approaches used, their relation to the specific research questions and the iterative process by which these methods produced the results reported in this thesis. The following section presents a brief introduction of the peoples, cultures and languages in the study area, and the reminder of the chapter introduces the different methods used to answer the research questions.

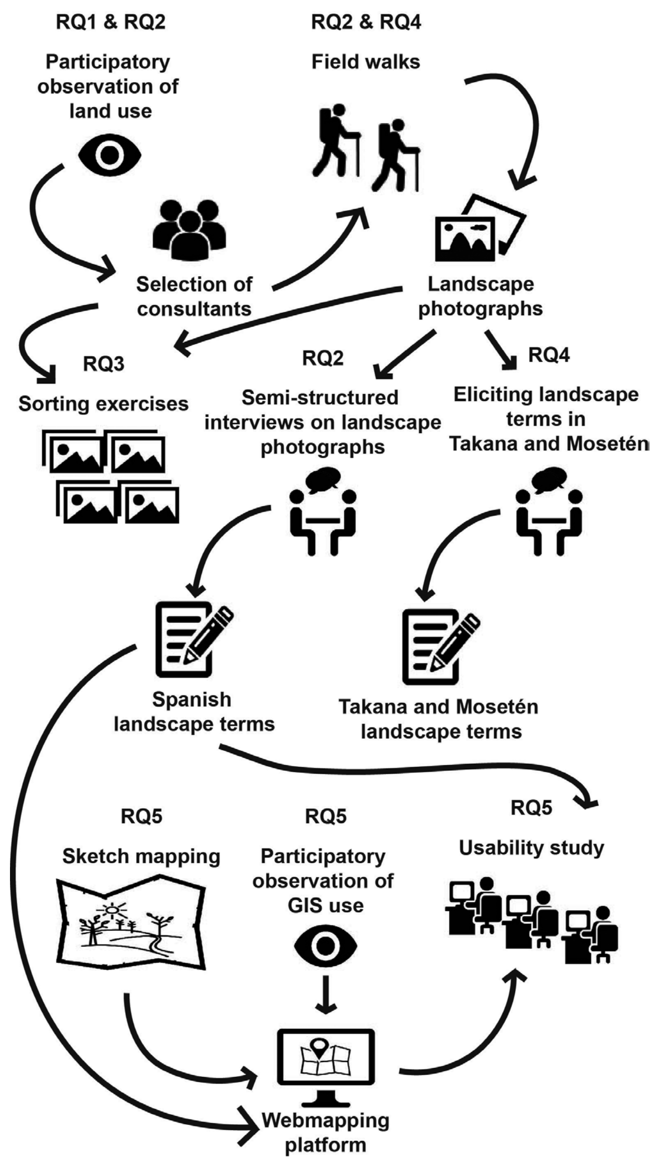

Fig. 8 Overview of methodological approach

4.1 Peoples, languages and cultures in the study area

In the study area, the Beni River constitutes the border between the two indigenous languages, Takana and Mosetén. Through colonisation, Spanish was introduced as a majority language, with some regional specifics. In the study area, most Takana indigenous people are now monolingual Spanish speakers, and the focus of this thesis was therefore on folk landscape categorisations in the local Spanish dialect, with some research on indigenous landscape terminologies in Takana and Mosetén. In the following, I introduce the local Spanish dialect, as well as the Takana and Mosetén language and culture insofar as it is relevant for my thesis.

Today, most people living along the western side of the Beni River in the study area (between Rurrenabaque and the confluence of the Beni and Tuichi River) self-identify as Takana, a cultural identity linked to other peoples in the Bolivian lowland of Guaraní descent who self-refer to their collective cultural identity as *camba*. The Takana language is an indigenous language traditionally spoken in the region around Tumupasha, Ixiamas and Rurrenabaque in the departments of La Paz, Pando and Beni in Bolivia. Takana, together with Araona, Caviñeno, Ese Ejja and Reyesano form the Takana language family. Takana has two variants, one from Tumupasha and one from Ixiamas, which speakers judge to be highly similar. Of the currently 5,000 people self-identifying as Takana, less than two thousand people still speak the Takana language (Adelaar and Muysken 2004), mostly in small, remote villages around Tumupasha and Ixiamas. Siyaya, a Takana woman in her fifties said:

Of the Takana language, much has been lost. Out of ignorance my father forbade us to speak Takana, they even forbade us to listen when they were speaking, because they thought it was bad. That is why we don't speak Takana anymore.

The Takana language was spoken in the study area until the 1960s, but today, Takana people in the study area are monolingual Spanish speakers of the local Spanish *camba* dialect, spoken in the Bolivian administrative departments of Santa Cruz, Beni and Pando (Pinto Mosqueira 2011). In the Beni region, this dialect is commonly referred to as *Beniano*. Lexically, the *Beniano* dialect contains a considerable number of loanwords from various indigenous languages (e.g. Chané, Chiquitano, Guaraní) and Portuguese, with loanwords being predominantly names for local plants and animals, as well as for foodstuffs and household items (Pinto Mosqueira 2011).

Contemporary Takana people are mainly small-scale agriculturalists producing crops such as rice, cassava, maize, beans and fruit on small plots spread throughout the rainforest. The Takana continue to hunt and fish for subsistence and maintain an extensive and detailed knowledge about local plants and animal species (CIPTA 2010; Tejada et al. 2006), using, for instance, a large variety of forest plants for food, construction, firewood, as well as for medicinal and religious purposes (Bourdy et al. 2000; DeWalt et al. 1999). Although Takana have been converted to Christianity through prolonged missionary activity in the area, the relationship of the Takana to their territory is, to some extent, still mediated through animistic religious beliefs. Spirits are thought of as the creators of all people, animals, plants and things. The spirits inhabit certain geographic areas that are considered sacred, such as mountain tops. As part of the sacralisation of the environment, the spirits, including the Mother Earth called *pachamama*, are offered coca leaves, alcohol and tobacco in the *cha'lla*. The *cha'lla* is a ritual of Andean origins that is also practiced in the Bolivian highlands (Macía, García, and Vidaurre 2005).

Mosetén is a slowly disappearing language spoken by roughly 800 people in the area of the Upper Beni river and the Quiquibey River (Sakel 2004). There are two dialects in Mosetén, the Covendo dialect spoken by around 600 people around the village of

Covendo, and the Santa Ana dialect spoken by around 150 to 200 people between Santa Ana and Muchanes along the Upper Beni River, as well as in some villages along the Quiquibey River. The Mosetén of Santa Ana shares a number of similarities with Mosetén from Covendo, as well as with the closely related Tsimane' language spoken by over 4,000 people. Tsimane' and Mosetén form the small Moseténan language family (Lewis 2009). So far, there is no confirmed relation of Mosetén and Tsimane' to other languages, and they are treated as language isolates (Sakel 2004).

4.2 Folk landscape categories in the Spanish Beniano dialect

To answer RQ2: *What categories are culturally recognised in a folk landscape categorisation and what are their ecological underpinnings and cultural significance?* I used a combination of methods informed from linguistics (Bohnemeyer et al. 2004), ethnophysiography (Mark and Turk 2003a) and landscape ethnoecology (Johnson and Hunn 2010).

During an exploratory phase in the first phase of fieldwork, I conducted participatory observation during over 200 observation hours, which provided an overview of people's activities in the landscape, such as hunting, fishing, agricultural tasks and medicinal plant collection. The goal was to understand local uses of landscape and the terms people use to refer to landscape units. When I presented my research proposal during community meetings in Villa Alcira the community suggested knowledgeable persons as local guides, and I also selected people based on the participatory observation. The goal of the field walks was to learn how Spanish-speaking Takana people name and use parts of the landscape, and to photographically document different landscape types. The guides chose transects along the extensive trail system and selected other locations to be visited outside their community for this learning to occur. Individual field walks lasted

between half a day and up to five days in the case of journeys to more remote locations. The documentation of field walks included handwritten notes and georeferenced photographs of different landscape units (Fig. 9 and 10).

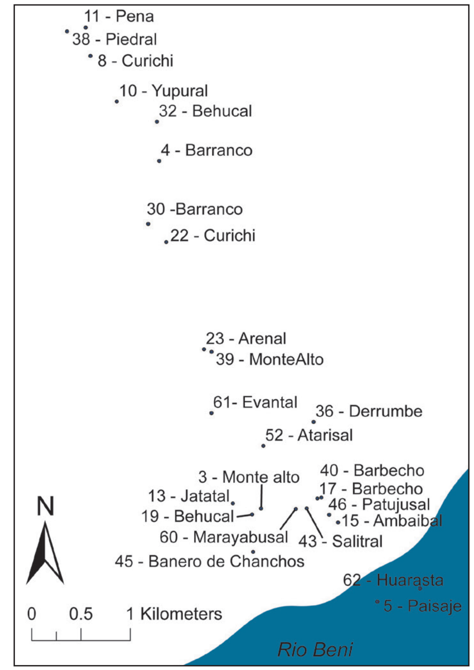

Fig. 9 Locations of photographs at study site near the Tuichi River

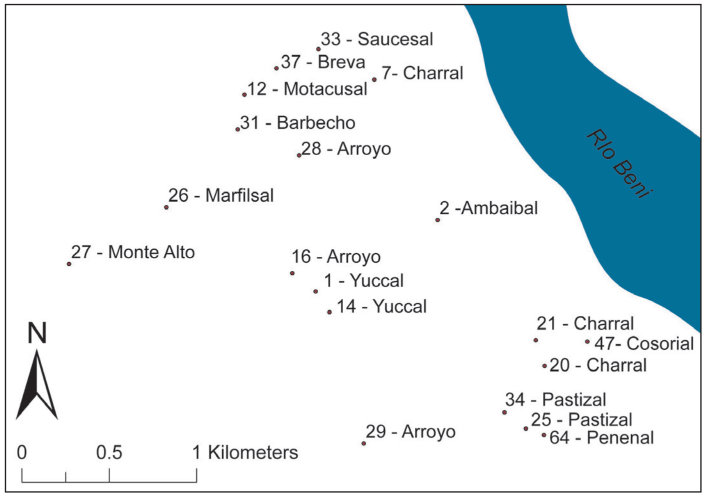

Fig. 10 Locations of photographs at study site in Villa Alcira

The second phase consisted of a research protocol based on semi-structured interviews with consultants about landscape photographs. To select consultants for interviews, I applied theoretical sampling, a qualitative research method in which individuals are purposefully approached to take part in the research (Crang and Cook 2007). In contrast to random sampling, the approach of theoretical sampling involves getting selective access to groups of people who, through their experience, occupancy or backgrounds, are concerned with the research topic, and encouraging people to teach the researcher about that topic (Crang and Cook 2007; Davidson-Hunt and Berkes 2010). Instead of relying on the 'typicality' or 'representativeness' of people, theoretical sampling places the importance on the positionality and the quality of information consultants can contribute (Crang and Cook 2007). For my fieldwork, the selection criteria were that consultants interacted with landscape on a regular basis (e.g. through activities such as hunting, fishing, or collecting plants) and that they had lived in the study area for ten or more years. Furthermore, I attempted to achieve a gender-balanced sample of consultants. To determine the size of the sample, researchers used the notion of theoretical sampling, that is, the point in the research process when accounts from new consultants fit within the range of stories that previous consultants have already told, which is either the point to start analysing the ethnographic material collected thus far, or, to seek out the opinions of another, differently positioned group (Crang and Cook 2007). I determined the point of theoretical saturation based on the number of new landscape terms mentioned during an interview. After three interviews that did not yield any new terms, I decided I had reached a point where, for the group I was working with, more interviews would not yield a considerable number of new terms.

At the start of the interview phase, the prompts for interviews consisted of 40 print-outs of photographs taken during field walks and five photographs of vegetation units from a botanical study of the Madidi area for comparative reasons (Fuentes 2005). Before the interview, I explained that I would like to learn about local names and uses of different types of landscapes. Because the Spanish term *paisaje* was not commonly used in the local dialect, in the elicitation phrase during interviews I used the Spanish term *lugares* (places). I asked consultants how they name such a place (*lugar*) that was portrayed on the photograph and how they used it. For every photograph, I took hand-written notes of the terms and local uses consultants mentioned. When consultants used a new term for a folk landscape category, I asked where I could find a location of the underlying referent. I then incorporated this location into a field walk in order to photographically document the referent.

Through this iterative process I added five more photographs to the set used in interviews, compiling a total of 50 print-outs of photographs as prompts for semi-structured interviews.

I chose to work with photographs as prompts, because the landscape photographs evoked consultants' memories of certain place (c.f. Wartmann et al. 2015), for which they then listed landscape categories. Most consultants were unfamiliar with the locations where the photographs had been taken, and listed generic terms rather than proper nouns or toponyms as descriptions for the photographs (with a few exceptions of stone formations known to some consultants, for example, that were identified and named as specific places). For each photograph, I selected the term mentioned by a majority of consultants and calculated the percentage of consultants who had used this term in describing the photograph as a measure for consensus on the use of landscape terms. The interviews commonly took place at consultant's homes for their convenience (Fig. 11).

Fig. 11 Interview on folk landscape categories with landscape photographs as prompts

In total, I conducted interviews with 19 consultants to elicit Spanish folk landscape categories, 14 of which were interviews with

individuals (10 men and 4 women) and one was a group discussion with 5 women. Consultants were between 23 and 65 years old. All consultants were fluent Spanish speakers, 15 were Beniano Spanish monolingual speakers (7 men, 8 women), 2 Mosetén-Spanish bilingual speakers (1 woman and 1 man) and 2 Takana-Spanish bilingual speakers (2 men).

Based on the landscape photographs used in interviews and the local plant names, botanist Alfredo Fuentes Claros at the National Herbarium, Universidad Mayor de San Andrés, La Paz provided scientific names for indicator plants. I complemented this information by comparing local names with existing species identification in the literature (DeWalt et al. 1999; Bourdy et al. 2000). As agreed with the Takana council CIPTA, I did not collect any herbarium plant samples.

For presenting the results on Spanish folk landscape categories (Chapter 6), the terms are grouped into thematic areas of vegetation, agriculture, substrate, topography, and water, as these are categories also commonly used in work on local landscape lexica (Johnson 2011; Krohmer 2010). A group for animal habitat accommodated landscape terms that specifically referred to dwelling places of animals. Importantly, these groups are externally defined and need not reflect the perspective of Takana on how landscape categories are structured hierarchically, which I investigated separately in RQ3.

To compare the Spanish folk landscape categories with an established scientific classification, I chose the etically defined group of vegetation, because there was a sufficiently diverse scientific classification of vegetation units available for the study area (Fuentes 2005). I conducted a semi-structured interview about the set of landscape photographs with Alfredo Fuentes Claros who had already identified the scientific names of indicator plants. For each landscape photograph, he provided the scientific botanical classification of the vegetation unit according to his publication on the Madidi area (Fuentes 2005).

4.3 Hierarchy and drivers for Spanish folk landscape categorisation

To answer research question 3: *How is the folk categorisation of landscape organised and what are drivers for landscape categorisation?* I conducted sorting exercises with landscape photographs followed by a semi-structured interview about the resulting arrangement. Previous studies on hierarchies of folk categorisations had often applied pile sorting with labelled cards (López et al. 1997; Medin et al. 2006). However, using written labels on cards may pose challenges to consultants who are very knowledgeable about the subject matter, but have little or no formal education and may find reading the labels troublesome or impossible. Studies working on landscape categorisation successfully applied sorting exercises with photographs (Klippel et al. 2015). For this study, I therefore chose to use photographs rather than labelled cards for the sorting exercise.

Of the 19 people I had interviewed on folk landscape categories, 9 (6 men and 3 women) afterwards also completed the sorting exercise. Similar sample sizes of 10 to 11 participants per study site were deemed sufficient for an exploratory study on landscape categorisation in Portugal (Williams, Kuhn, and Painho 2012).

An important part of fieldwork was embedding the more experimental tasks in an explanation accepted by consultants. During participatory observation, several consultants stated they had disliked being part of previous research projects, especially when they didn't understand the project's purpose. Although it may seem like a minor concern, providing an explanation of the research and a background for tasks that consultants are asked to perform is crucial to ensure their collaboration, as people get bored or annoyed with tasks that seem to make no sense to them. During interviews, some consultants had stated that the photographs were 'not ordered' and that I should order them.

Thus, I decided on using the following instruction for the sorting exercise (originally in Spanish):
These photographs are currently not ordered. Can you order them?

This was a well accepted explanation and one consultant replied:

Yes, I can see these photographs need ordering, they are in a mess.

(Field notes, July 2014)

The sorting exercises took place either directly after the interview on landscape photographs or several days apart (because of time constraints of consultants). As a preparation for the sorting task, I put a large sheet of packing paper (1m x 2m) on the ground or on a table (if available) and distributed the 50 landscape photographs in a random order on the sheet.

Fig. 12 Consultant arranging landscape photograph in a sorting exercise

Before the exercise I stated that consultants were free to order the photographs in whatever way they wanted, and that there was no right or wrong way. Consultants were able to question me during the experiments for clarification purposes. During the sorting exercises I took hand-written notes if consultants were explaining their grouping. I documented the resulting arrangements of photographs with digital camera. Once consultants had arranged all the landscape photographs on the sheets of paper (Fig. 12), I asked them to explain the arrangement and the criteria they had used to organise the photographs. If the arrangement was continuous, I asked consultants if they could identify groups, and how they would name them. I noted down the term consultants gave each group and what photographs were members of this group by noting down the numbers written on the back of photographs for each group. For each group of photographs, I asked consultants to point out a typical example.

To analyse the results of the sorting exercise, I first used open coding on my interview notes and in a second step used these codes for structured coding (Crang and Cook 2007). For a more quantitative approach, for each combination of photographs, I summed up the number of consultants who had grouped these two photographs together in the same group. This resulted in a matrix with values of 0 to 9 (none or all consultants grouping the photographs together, respectively).

4.4 Landscape categories in Takana and Mosetén

For research question 4: *How does the categorisation of the same landscape differ between different groups of people?* I investigated landscape terminologies of Takana and Mosetén speakers. I used the set of 50 photographs compiled for interviews with monolingual Spanish speakers. The indigenous council CIPTA recommended two male Takana-Spanish bilingual speakers as consultants, and I asked the wife of one of these consultants who was fluent in Takana and Spanish to be a con-

sultant. The Takana landscape terms are thus based on work with 3 consultants from Tumupasha: Leonardo Marupa Amutari (†), Fransisco Quenevo Chao and Isidora Cartagena Amutari, who provided terms and phrases in Takana and explained them in Spanish. Leonardo Marupa also annotated terms in Takana using the phonology documented by French linguist Antoine Guillaume in his grammar of the Takana language (Guillaume 2013). The landscape terms presented in the results are based on interviews and annotations by consultants that were cross-checked and complemented with landscape terms from two unpublished Takana-Spanish/Spanish-Takana dictionaries (Ottaviano and Ottaviano 1989 and CIPTA 2011). Interviews with Takana consultants on Takana landscape terms were in Spanish, which as bilingual speakers, all consultants were fluent in.

For my research on Mosetén landscape categories I approached the indigenous authorities of the Consejo Regional de Tsimane'-Mosetén (CRTM) in Rurrenabaque with a research proposal, which they accepted. However, when I approached the community of Asunción del Quiquibey to conduct field walks and interviews in their community, the board of elders rejected the proposed work based on 'bad experience' they had with previous researchers, mainly the complete lack of collaboration on the part of the researchers, and no sharing of results despite promises to submit the written thesis and a summary in Spanish. Therefore, I then approached 2 individual Mosetén speakers living in Río Hondo who I knew from my previous research. Furthermore, Helen Gambon, an anthropologist from the Centre for Development and Environment in Berne, Switzerland, introduced me to two more Mosetén speakers living in Rurrenabaque. Helen Gambon, who worked in several Mosetén communities along the Quiquibey River, introduced me to the community in Gredal on the Quiquibey River, where several people agreed to be consultants on Mosetén landscape terms. The Mosetén landscape terms presented in the results section are mainly based on interviews with two men and two women who were Mosetén-Spanish bilingual speakers (for three of them, their first language was Mosetén): Felix Tureno, Germán Soto Villanueva, Regina Chita Canare and Ruxanna Huasna. Interviews with Mosetén consultants from Gredal and Río Hondo were in Spanish, a language in which all consultants were fluent. No translators were present during interviews. Furthermore, consultant Clever Clemente Caimani of CRTM annotated terms in the Santa Ana variant of Mosetén using the writing system elaborated by Colette Grinevald for Mosetén documented in an unpublished manuscript cited in Sakel (2004). Where possible, the landscape terms presented in the results were cross-checked with existing terms in a Mosetén-Spanish/Spanish-Mosetén dictionary (OIM 2011). However, few of the elicited Mosetén landscape terms were contained in the dictionary.

4.5 Representing local understandings of landscape on maps and in GIS

In order to answer RQ5: *How can local understandings of landscape be represented on maps and in a GIS?* I used different methodological approaches from anthropology to computer science. In the following, these approaches are outlined in more detail.

The first approach was to conduct sketch mapping exercises to investigate consultants' conceptualisation of their environment, and the geographic features they represented on a map. The mapping exercises took part in two different settings. The first setting was at people's home in the study area (Fig. 13a), and the second setting was mapping exercises during workshops or community meetings (Fig. 13b).

Fig. 13 Consultants conducting sketch mapping

Fig. 13a Sketch mapping at consultant's home

Fig. 13b Sketch mapping at community workshop

I conducted a total of five workshops during which sketch mappings took place. Two workshops were with members of CIPTA in Tumupasha (3 days in total), one with members of CRTM in Rurrenabaque (1 day), and one workshop in Villa Alcira (1 day). In the introduction to the task in the workshops, I explained that consultants should map what they thought was important of the surrounding area. I provided sheets of packing paper (1m x 2m) and pencils in black, green, red and blue to each consultant. Consultants were free to choose of what features to represent and how to represent them. After the sketch mapping exercises, I asked consultants to explain the maps. In total, 29 consultants drew a sketch map, 22 men and 7 women, of which four men had also completed the interview on landscape photographs and the sorting exercise. A gender balance of consultants was not achieved because workshops were frequented by more men than women. In order to spatialise the sketch maps, I conducted field walks with four men to georeference the features represented on the map using a handheld Garmin Oregon (Garmin Ltd., Olathe, Kansas) GPS device.

A second methodological approach was to use participatory observation to analyse the current use of GIS in local organisations involved in land management and to identify challenges. I conducted participatory observation with staff members responsible for managing the GIS at the CIPTA indigenous council in Tumupasha, the CRTM indigenous council in Rurrenabaque, and the SERNAP local offices in San Buenaventura and Rurrenabaque. Participatory observations took place both during visits (daily business) as well as during workshops on mapping and GIS I conducted for these organisations (Fig. 14).

Fig. 14 Identifying the uses and needs for a GIS with Madidi protected area staff members

Based on this information I elaborated a list of hard and soft criteria that a system for representing landscape would need to fulfill. The results for this evaluation led to the selection of the Cartaro web mapping platform described in the next paragraph.
Cartaro is a web mapping platform that brings together open source geospatial components PostGIS, GeoServer and OpenLayers into the Drupal content management system (CMS), as shown in Figure 15.

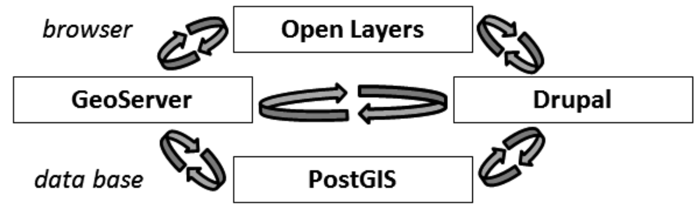

Fig. 15 Architecture of the Cartaro web mapping platform

Access to geospatial data in Cartaro is handled by GeoServer, a Java-based open source software server that allows users to share and edit geospatial data. It uses open standards for interoperability, and publishes data from any major spatial data source. To publish images or vector data, GeoServer queries the PostGIS database, a free and open spatial database extender for PostgreSQL object-relational database. PostGIS adds extra types (e.g. geometry, raster), functions, operators, and index enhancements that apply to these spatial types to the PostgreSQL database management system. PostGIS thereby adds support for geographic objects, making it a fast and robust spatial database management system as it runs location queries in SQL.
Through the GeoServer module, Cartaro supports the main web services defined by the Open Geospatial Consortium (OGC), such as the Web Map Service Interface Standard (WMS), the Web Feature Service Interface Standard (WFS) and Web Feature Service Transactional (WFS-T). WMS provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, and other file formats) that can be displayed in a browser application. The WMS returns only an image that cannot be edited or spatially analysed by users. By contrast, a WFS provides an interface allowing querying and retrieving

geographical features based on spatial and non-spatial constraints across the web using platform-independent calls. In addition, WFS-T allows creating, deleting, and updating features. For both WFS and WFS-T, data passed between a Web Feature Server and a client is encoded with Geography Markup Language (GML), an XML dialect which can be used to model geographic features. OpenLayers is a pure JavaScript library for displaying map data in most modern web browsers, implementing a Java Script API for building web-based geographic applications.

To evaluate the Cartaro webmapping platform I performed a simple usability study (Nielsen 1994). As a setting for the usability study I conducted three workshops where I introduced Cartaro to SERNAP protected area management staff and two indigenous organisations (CRTM and CIPTA). Cartaro was installed locally on three laptops that were donated to the respective organisations after the workshop. After an introduction and trial that lasted less than an hour, I conducted short informal interviews with workshop participants on the usability of Cartaro. In total, 8 individuals participated in the usability study, which is more than the suggested 5 participants that were shown to be sufficient for detecting major usability challenges (Virzi 1992).

4.6 Reflections on positionality and reciprocity

The photograph on the title page shows a view of the Beni River and the surrounding forests, a view I enjoyed many times when taking a boat upriver. Each time I looked at this landscape, it was more or less the same landscape of a river flowing through tropical rainforest, but my perception of it changed. The first time I saw this view I was a tourist coming to the Bolivian lowland for a hiking trip in the rainforest. I was fascinated by the lush jungle and the scenic beauty, and I was eager to explore what animals and plants I would discover on the hike that lay ahead. The second time I came to volunteer as a consultant for an indigenous tour operator. Working in the tourism industry, I observed how

the imaginary of an unexplored 'jungle' and the Madidi as a biodiversity hotspot that I had held were used for marketing purposes. I started realising how these imaginations contrasted to the forest as a place where indigenous people lived and worked, and how for them, the rainforest was not simply a biodiversity rich space devoid of culture, but a culturally infused landscape filled with stories and meaning. This change in perspective also reflects a shift in positionality over the course of the time I spent in Bolivia. I started as a tourist, a complete outsider, then became a staff member of an indigenous tour operator, and finally a researcher living and working for several months a year in the area over the course of three years. In the following sections, I will highlight aspects of positionality and reciprocity during the course of my fieldwork. I define fieldwork as work conducted for my PhD at a study site in Bolivia. However, localising 'the field' in ethnographic research is increasingly challenged (Watson 2012). The argument is that over time, as we develop rapport and build friendships and ties not only with consultants, but with other people, we start to feel 'at home' in 'the field', and it is difficult to maintain a strict distinction between the two, as the field starts to feel like home and home can become part of the field when maintaining contact with consultants also when not physically present 'in the field', but back at our respective institutions. Although I am aware of the difficulties of 'bordering the field', in the following section I focus on a geographical definition of the field and my positionality during work conducted while in Bolivia.

4.6.1 Positionality during fieldwork

Feminist and poststructural research challenged objective (social) sciences and urged researchers to reflect on their positionality and their power relations in fieldwork (Adams 1998; England 1994; Kaspar and Landolt 2016; Watson 2012). The aim of such self-reflection is to be more sensitive to unequal power relations in the field, which encompasses the nature of interactions between the researcher and the researched:

[…] those who are researched should be treated like people and not as mere mines of information to be exploited by the researcher as the neutral collector of "facts."

(England 1994, p. 82)

Although England's statement today may seem obvious, reflections on positionality are far from being considerations of the past, but remain important in empirical research (Bourke et al. 2009; Franks 2013; Mellor et al. 2014), including landscape and place research (Williams 2014). In the following section, I trace my shifting positionalities during the different phases of my work in Bolivia, and highlight how my positionality influenced the process of data collection and ultimately the results of this thesis.

When I was working as a volunteer for an indigenous tour operator before I started my PhD, a Takana family invited me to live with them, which I continued to do throughout the duration of fieldwork for my thesis. The affiliation with this family enabled me to talk to and interview many people who trusted me *because* I lived with this family (and by accepting me under their roof implicitly vouched for my integrity). The oldest son of my host family accompanied me on my visits as a boat driver, and quickly started working for me as a local assistant, helping in selecting the places to visit and the people to contact (which were often members of his extended family network or former work colleagues). Whether or not the people we approached would agree to talk with me depended on his positionality (a young educated men from a Takana family with modest financial resources) as well as on mine (a young educated non-indigenous woman from Europe). Working with a man it was considered acceptable for me to approach other men, and as a woman, it was unproblematic to work with women. The fact that I spoke

fluent Spanish in the local dialect, and that I did not stay at a local hotel with constant hot water and air condition set me apart from tourists, who were sometimes perceived as being arrogant and distant. I ate and drank whatever I was offered, including river water and meat from wild game, because this felt like the 'right thing' to do and seemed more culturally acceptable than insisting on purifying drinking water or keeping a vegetarian diet. Although we never used the (Spanish equivalent) for the term positionality, I often discussed some aspects with my assistant who was guiding me on how to best interact with people.

The bias that I introduced through the close affiliation with one family and their relatives and by working with a family member as an assistant might have resulted in some people not talking to me because they were not on good terms with this family. I tried to circumvent this bias by working also in villages where my host family did not have many ties. Some consultants for field walks were also selected by the local community. My positionality thus played a major role in who I approached as consultants, where these consultants would take me on field walks and in turn, which sites I photographed and what prompts I used in interviews and sorting exercises. After several months of working with my assistant, he decided to stop working with me to stay in town with his wife and child. From that point on, I conducted field work on my own, which, at least at the later stages of my research, decreased the initial bias of working within one family's extended network as I continued to select and work with consultants on my own. Consultants who had known my assistant asked why he was no longer joining for the visits, to which I replied that he had to stay with his wife in town. Several consultants expressed their appreciation that I still visited them on my own. My decision to continue working alone, instead of searching for a new assistant therefore did not seem to negatively affect rapport with consultants.

An important aspect of the relation between the researcher and the researched is reciprocity, which I elucidate in the next section with respect to my fieldwork.

4.6.2 Reciprocity in fieldwork

Despite awareness of treating people with respect and consideration during fieldwork, and the best intentions of researchers notwithstanding, ethnographic writings highlighted how power relations between the researcher and researched were often asymmetrical in favor of the researcher (England 1994). While I could influence where I lived and how, I could not influence that I was a foreigner and compared with local living standards relatively affluent, which could be deduced from my travels to Bolivia by airplane, and my clothes and equipment such as backpack and hiking boots. It was suggested that researchers should do everything possible to remedy this asymmetrical relationship (Adams 1998). One way of doing so is through reciprocity, which is considered repayment for help provided by those researched in the field, which can take monetary (paying consultants for their time) or non-monetary forms (e.g. helping consultants with their work, sharing research results etc.). During my fieldwork, I chose to use different forms of reciprocity. In dealing with the Takana and Mosetén Indigenous Councils, the two councils each expressed their expectations of how reciprocity should be achieved. Each council drafted a contract to specify the terms of the interaction with indigenous groups during research that I signed. In these contracts, I agreed that I would hire people for field walks, present my results to the council on a regular basis and when my fieldwork was completed, hand in a summary of my thesis in Spanish, and present my results to communities in an accessible way in Spanish. The indigenous councils had drafted these contracts based on previous experiences with researchers who did not engage in reciprocity. The contract was a way of assuring that researchers working with Takana and Mosetén communities

were, at least in principle, committed to sharing their results. However, once a researcher completed fieldwork the councils had little power to sanction non-compliance with the contract. During each fieldwork phase I visited both the CRTM and CIPTA office at least once to give an informal update on my research. I handed in an abbreviated version of approximately 60 A4 pages of the thesis translated to Spanish to CRTM, CIPTA, and the Madidi and Pilón Lajas SERNAP offices.

At a community level, I presented my work at several village meetings in Villa Alcira, first to obtain permission from the community to conduct research in Villa Alcira during my first phase of fieldwork, and a second time after a year where the community decided whether I was allowed to continue my research project. I hired several people from Villa Alcira as guides for field walks, and I conducted the workshops they had requested on mapping with GPS. After my fieldwork was completed, I presented my results in the form of a pictorial booklet at the village meeting and handed out booklets to all village members. These pictorial dictionaries (200 printed copies in total) I also distributed to all consultants whom I had worked with (although I was unable to locate some consultants who lived in more remote areas). Although there was some criticism about the booklets, they were generally well received. The most common question was why I had not included the Tsimane' language. I honestly answered this by stating that I had tried on several occasions, but that my proposals were rejected at village meetings, to which people replied: 'but you should try again now, now we know that you don't just promise and don't deliver'. Another question people asked why I chose to include Mosetén (if they were Takana), or Takana (if they were Mosetén) instead of only 'their' indigenous language, to which I replied that these languages were both spoken in the Madidi area (the title of the booklet).

Consultants who had contributed directly during field walks appreciated the booklet as a form of recognition of their efforts to teach me about terminology and uses of the land. Several consultants of meetings where I distributed the booklets remarked that they (the indigenous people) should ask for such 'tangible results' from all researchers and students who work with their communities. I interpreted these statements in two ways. Firstly, it seemed that the considerable additional work I had put into layouting and producing such a booklet was appreciated, and secondly, that researchers were generally perceived as being very extractive and not sharing their results. When I asked some of my consultants about this subject, they shared several accounts of how their communities and families had worked with researchers only to be disappointed that they never saw any report or thesis afterwards, let alone some more accessible format of presentation of results.

Although I tried to focus on non-monetary ways of reciprocating, during my fieldwork, consultants sometimes asked to borrow money from me. Being aware of issues that this could cause, I often refused, but not always. I don't claim I was always consistent, or fair, and sometimes I gave in to pleas for money on the spur of the moment, but mostly only after consulting with my assistant on whether giving money to this particular person or family would create issues with the community or not.

Although I tried to find ways in which to achieve reciprocity during my fieldwork, and reactions of several people indicated that at least, in part, I seemed to have achieved this, it is possible that without knowing, I created expectations that I could not fulfill, or my attempts at reciprocity fell short of such expectations. One such expectation I am aware of relates to the mapping aspect in my work. Some village members expected me to produce a topographic map of their village, in the same way a topographer they had paid a considerable sum had once done for their village. When it became clear that I was conducting some other form of mapping that involved training community members in mapping, and that I was not a topographer who was going to measure

boundaries and distances, they openly voiced their disappointment at a community meeting. During the meeting I then had to react to accusations of not doing any mapping at all, and was suspected of instead being a bioprospector. I then explained in front of the community members again the goal of my research, and that there are different forms of mapping with different purposes. This open communication helped to resolve the mismatch in expectations and what I was going to deliver.

Importantly, as researchers today we often don't work in settings anymore where 'nobody has gone before'. Often, the sites we visit and select as the place to conduct our fieldwork other people have visited before and have done their research there before us, or NGOs have implemented projects. Depending on the experiences people have made, this influences how and where we can conduct fieldwork. For example, when I tried to include other Takana and Mosetén communities along the Beni river, village assemblies in two villages declined the proposal I presented at the village meeting, stating they had had 'enough research and empty promises'. This experience illustrates that apart from an ethical obligation towards consultants in one's own research project, fulfilling reciprocity is also an obligation as a researcher in general. Only when researchers in the field achieve good rapport with the people they work with and live up to the expectations they had created, we enable other researchers still to come to find people still willing to participate in research.

I watched the surrounding
landscape with great curiosity,
and I wanted to discover the words
that could describe all its unspoiled beauty.
Daniel J. Rice in: The Unpeopled Season: Journal from a North Country Wilderness (2014)

Chapter 5
Folk landscape categorisations in the Spanish Beniano dialect

In this chapter, I answer RQ1: *What categories are culturally recognised in a landscape folk categorisation and what are their ecological underpinnings and cultural significance?*

In total, the elicited folk landscape categories people used to identify and refer to different landscape units in the Bolivian Amazon consisted of 156 categories. For a better understanding, these folk landscape categories are divided into groups commonly used in the landscape ethnoecologist literature (Johnson 2011; Krohmer 2010). The largest variety of elicited terms referred to vegetation units (60 terms), followed by terms for agricultural units (30), water (27), topography (25), substrates (13), and 1 zoogenic unit.

5.1 Folk vegetation categories

The group of vegetation contained the largest number of landscape categories. Consultants identified 60 different categories related to vegetation. Most of these categories were identified and named according to visually salient indicator plants or plants with specific local uses (Tab. 2).

Indicator species belonged to 27 taxonomic plant families. The majority were woody plants, with fewer herbaceous plants. Ten

vegetation units were named after palms, the palm family *Arecaceae* was thus the most represented plant family.

Tab. 2 Folk vegetation categories and indicator plant species

Local Spanish term	Approximate English equivalent	Scientific name of indicator species	Plant family
achachairusal	stand of *achachairú* trees	*Garcinia guacopary* (S.Moore) M.Nee	*Clusiaceae*
ambaibal	stand of *ambaibo* trees	*Cecropia concolor* Willd. *C. membranaceae* Trécul	*Urticaceae*
asaisal	stand of *asaí* palms	*Euterpe precatoria* C. Martius	*Arecaceae*
atarisal	stand of *atarisi* plants	*Polypodiaceae* family, ferns in general,	*Polypodiaceae*
		usually dense stands of *Gleicheniaceae*	*Gleicheniaceae*
		or *Pteridium arachnoideum* (Kaulf.) Maxon.	*Dennstaedtiaceae*
		Cyclopeltis semicordata (Sw.) J. Sm.	*Tectariaceae*
balsal	stand of *balsa* trees	*Ochroma pyramidale* (Cav. ex Lam) Urb.	*Malvaceae*
bejucal	stand of lianas	various species	*Bigoniaceae* and others
bibosisal	stand of fig trees, also called *matapalo*	*Ficus* sp., e.g. *Ficus maxima* Miller *F. pertusa* L.f.	*Moraceae*
bisal	stand of *bi* trees, also called *manzana del monte*	*Genipa americana* L.	*Rubiaceae*
cachichiral	stand of *cachichira* trees	*Sloanea obtusifolia* (Moric.) K. Schum	*Elaeocarpaceae*

cahuaral	stand of *cahuara* plants	*Tessaria integrifolia* Ruiz & Pavon	*Asteraceae*
cañaveral	area of *caña* plants	*Saccharum* spp.	*Poaceae*
cañuelal	area of *cañuela* plants	Various species such as *Hymenachne amplexi-caulis* *H. donaciifolia* *Polygonum spp.*	*Polygonacae*
camururusal	stand of *camururu* trees	*Garcinia madruno* (Kunth) Hammel	*Clusiaceae*
cedral	stand of *cedro* trees	*Cedrela odorata* L.	*Meliaceae*
chaquillal	stand of *chaquillo* trees	*Physocalymma scaberrimum* (Pohl)	*Lythraceae*
charillal	stand of *charillo* plants	Depauperated *Gynerium sagitattum* growing on dry and poor soils	*Poaceae*
charral	stand of *charo* plants	*Gynerium sagittatum* (Aubl.) P. Beauv.	*Poaceae*
chaparral	type of wet forest	various species	–
chimal	stand of *chima* palms	*Bactris gasipaes* Kunth	*Arecaceae*
chontal	stand of *chonta* palms	*Astrocaryum murumuru* Mart. *A. ulei* Burret	*Arecaceae*
chuchial	stand of *chuchio* plants (synonymous for *charo*)	*Gynerium sagittatum* (Aubl.) P. Beauv.	*Poaceae*
chumirisal	stand of *chumiri* trees	*Trema integerrima* (Beurl.) Standl.	*Ulmaceae*
comedero	feeding place for animals	various species	–

copal	stand of *copa* palms (also called *pachiuba*)	*Iriartea deltoidea* Ruiz & Pav.	*Arecaceae*
cortaderal	stand of *cortadera* plants	*Cyperaceae* spp. with cutting margins	*Cyperaceae*
cosorial	stand of *cosorió* trees	*Erythrina fusca* Lour. *E. dominguezii* Hassl. *E. peoppigiana* (Walp) O.F. Cook	*Fabaceae*
enredaderal	area with a lot of lianas	various lianas	–
espinal	area of spiny or thorny plants	various species, frequent-ly *Fabaceae-Mimosoideae* such as *Senegalia* spp.	*Fabaceae*
evantal	stand of *evanto* trees	*Angostura longiflora* (K. Krause) Kallunki	*Rutaceae*
gabetillal	stand of *gabetillo* trees	*Aspidosperma excelsum* Benth. *A. rigidum* Rusby	*Apocynaceae*
japainal	stand of *japaina* plants	*Heliconia episcopalis* Vell.	*Heliconia-ceae*
jatatal	stand of *jatata* palms	*Geonoma deversa* (Poit.) Kunth *G. interrupta* (Ruiz & Pav.) Mart.	*Arecaceae*
majal	stand of *majo* palms	*Oenocarpus bataua* Mart.	*Arecaceae*
maral	stand of *mara* trees	*Swietenia macrophylla* King	*Meliaceae*
marayausal	stand of *marayaú* palms, also *marayabú*	*Bactris major* Jacq. *B. concinna* Mart.	*Arecaceae*
marfilsal	stand of *marfil* palms	*Pytelephas macrocarpa* Ruiz & Pav.	*Arecaceae*
matorral	scrubland, shrubland	various species	–

momoquisal	stand of *momoquí* trees	*Caesalpina pluviosa* DC.	*Fabaceae*
monte alto	forest	various species	–
monte alto raso	forest with clear understory	various species	–
monte alto tupido	forest with dense understory	various species	–
monte espeso	forest with dense understory	various species	–
motacusal	stand of *motacú* palms	*Attalea phalerata* Mart. ex Spreng.	*Arecaceae*
pajonal	scrubland	various species	–
pacaysal	stand of *pacay* trees	*Inga* spp. such as *Inga nobilis* Willd.	*Fabaceae*
palmar	stand of palm trees	*Palmae* spp.	*Palmae*
palmareal	stand of *palma real* palms	*Mauritia flexuosa* L.f.	*Palmae*
pantano	swamp, wetland	–	–
pampa	grassland, flat area (also inside the forest)	–	–
patujusal	stand of *patujú* plants	*Heliconia rostrata* Ruiz & Pavon	*Heliconia-ceae*
penenal	stand of *penena* plants	*Guadua sp.* Kunth	*Poaceae*
picapical	stand of *picapica* plants	*Urera baccifera*	*Urticaceae*
saucesal	stand of *sauce* plants	*Salix humboldtiana* Willd.	*Salicaceae*
selva	primary rainforest / jungle	various species	–

tacuaral	stand of *tacuara* plants	*Guadua weberbaueri* Pilg.	*Poaceae*
tupisión	dense vegetated area	various species	–
uñagatal	stand of *uña de gato* liana	*Uncaria guianensis* (Aubl.) J.F.Gmel *U. tomentosa*	*Rubiaceae*
vainillal	area of vanilla plants	*Vanilla planifolia* Jacks. ex Andrews	*Orchidaceae*
yomomal	stand of *yomomo*	various species	*Pontederia-ceae* *Poaceae*
yupural	stand of *yupura* plants	*Calliandra angustifolia* Spruce ex Benth.	*Fabaceae*

At least 30 folk vegetation units had specific uses in local culture. For instance, a place where there is plenty of *jatata* (*Geonoma deversa*) was called a *jatatal* (Fig. 16a). *Jatatales* were important harvesting sites, because although *jatata* palms grow dispersedly throughout the rainforest, Takana people deemed it unfeasible to collect the plants at such low densities. The *jatata* palm was used to construct roof thatching for traditional Takana homes. The plant was of high economic importance to the Takana, as thatched *jatata* roofs were not only produced for personal use, but also sold on local markets. Customary management of *jatatales* included access regulations meditated through family or community membership as well as traditional harvesting practices. The Takana only cut off leaves allowing palms to re-grow from their stalks, which was more labour intensive then cutting the palms down to the ground, but allowed the continued use of the same *jatatal*.

Fig. 16 Examples of instances for folk vegetation categories

Fig. 16a *Jatatal*

Fig. 16b *Charral*

Another example of local usage was the vegetation stand called *charral* characterised by dense stands of *charo* plants (*Gynerium sagittatum*). A *charral* grows in riverine habitats as pioneer vegetation on sandy riverbanks (Fig. 16b). The lignified *charo* stalk had several local uses, for instance, to construct house walls, fences for domestic animals or drying racks for meat and fish. When hunting and fishing, people often used *charo* stalks to hang mosquito nets or covered them with *charo* leaves for protection against rain and dew. In addition, for hunters, a *charral* was a good area to look for resting tapirs during the day. In general, however, people avoided crossing a *charral* unless there were established trails, because of the density of the vegetation.
One of the few examples of a vegetation unit not named after a certain plant species or genus was the landscape category *monte alto* (Fig. 17a), the local term for old-growth or primary rainforest. The category is further distinguished into *monte alto razo* (old-growth rainforest with clear understory, Fig. 17b) and *monte alto tupido* (old-growth rainforest with dense understory).

Fig. 17 Examples of instances for folk vegetation categories of rainforest

Fig. 17a *Monte alto*

Fig. 17b *Monte alto razo*

The *monte alto* is central to Takana livelihoods: as hunting ground for a variety of animal species, as a place to collect medicinal plants, firewood, and construction material. In the Takana belief system, the *monte alto* is inhabited by spirits who need to be treated respectfully. When entering the forest, hunters often chewed coca leaves and smoked tobacco as a form of protection against spirits such as the *dueño del monte* (Master of the Forest). Several consultants mentioned that the *monte alto* was a good place for making contact with spirits and therefore important in the local belief system. Parents avoided taking babies and small children to the *monte alto*, as malevolent spirits who dwell there were believed to cause the sickness *malviento* (lit. bad wind), characterised by fever, vomiting, and diarrhea that can only by cured through spiritual treatment by an experienced *curandero* (shaman). Consultants mentioned that the *monte alto* was also important for their (mental) well-being, as Joquín stated:

If I don't go to the forest for more than a week I get a headache, I need to be in the monte, there I am at peace, there I feel well.
(Field notes August 2013)

Other consultants mentioned aspects such as the beauty of the *monte alto* as well. These statements speak to the importance of aspects of the landscape that link to well-being and aesthetic beauty, which go beyond the immediate use of certain landscape units for local use.

Key messages Folk vegetation categories

- Consultants identified 60 different folk vegetation categories, most of these categories were identified and named according to visually salient indicator plants or plants with specific local uses
- At least 30 identified vegetation units had specific local uses or cultural significance.

5.2 Folk agricultural landscape categories

Chaco is the general term for agricultural plot. The types of *chacos* are named according to the planted crop. For instance, the term *arrozal* for rice field is derived from the Spanish *arroz* (rice). Similarly *platanal* (banana planation, Fig. 18a) is derived from *platano* (plantain). Several terms indicate different stages in the cycle from clearing forest to producing an agricultural plot: a *chaco tumbado* (logged plot) refers to an area where large forest trees had been felled. The plot is then cleared of understory vegetation and becomes a *chaco rozado* (cleared plot). Once the plot had been burnt and is ready for crop planting it is called *chaco quemado* (burnt plot, Fig. 18b).

Fig. 18 Examples of instances for folk vegetation categories

Fig. 18a *Jatatal*

Fig. 18b *Charral*

A *chaco* is, for instance, planted with rice in the first growing season and later with maize, yucca, beans or pineapple that produce good yields for up to 4 years. The plots are then left fallow for several years up to several decades, depending on the needs of the family who cultivate the plot. Such fallow plots are called *barbecho*. Takana people distinguish different stages: after one or two years a fallow plot is called *barbecho nuevo*, after five to ten years *barbecho medio* and after ten or more years *barbecho alto* or *barbecho viejo*. The crops in old fields produce harvests even years after the initial clearing and planting of the field, making them important resource areas interspersed with old growth forest. Barbechos also attract important game species such as the spotted paca (*Cuniculus paka*) or white-lipped peccaries (*Tayassu pecari*).

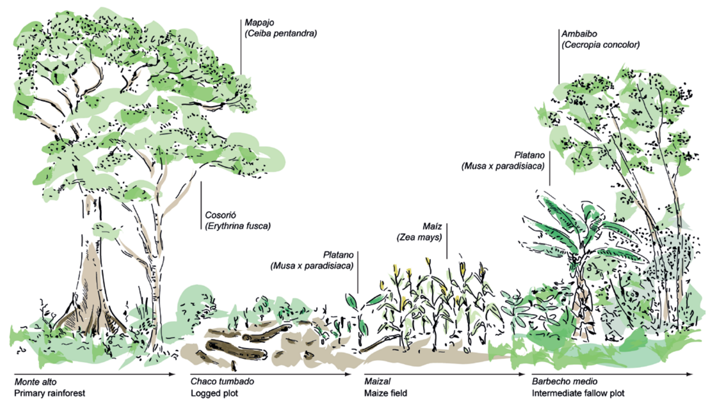

Fig. 19 Succession from rainforest to agricultural field and fallow field (own adaptation of ink drawing by Pia Bereuter, University of Zurich)

The cycle of temporal succession of the conversion of forest to agricultural areas that are left fallow is illustrated in Figure 19. The distinction between an old fallow plot and primary forest of the *monte alto* is difficult to notice for outside observers, as also the fallow plot seems to have the typical characteristics of a primary rainforest. However, this distinction is important in the local land tenure system, as *barbechos* are associated with certain use rights. The descendants of the person who first cleared the plot derive use rights from the labour invested in its clearing. Miguel stated that:

I showed them [from the park] *my barbecho. All that I have done, you can see well that I have worked here. It's the plants that testify how long we have lived here. Show me your barbecho, or show me your field with mandarines, grapefruits and oranges, and I will believe you that you have lived here.*

(Field notes July 2012)

Consultants identify 30 distinct agricultural areas, such as different types of agricultural plots and orchards (Tab. 3).

Tab. 3 Folk agricultural landscape categories

Local Spanish term	Approximate English equivalent
arrozal	rice field
barbechal	area of fallow plots
barbecho	fallow plot
barbecho alto	old (lit. high) fallow plot
barbecho medio	intermediate fallow plot
barbecho nuevo	new fallow plot
barbecho viejo	old fallow plot
breva	plot with first growth plantain
chaco	agricultural plot, field
chaco quemado	burnt plot
chaco remontado	overgrown plot
chaco rozado	cleared plot
chaco tumbado	logged plot
chaqueado	agricultural plot, field
chocolatal	cacao plantation
frijolsal	bean field
frutal	fruit orchard
limpio	clear area
maizal	maize field
mangal	mango orchard
naranjal	orange orchard
papaysal	papaya plantation
pastizal	grazing area
piñal	pineapple plantation
platanal	plantain plantation
potrero	grazing area
rastrojo	stover
rozado	cleared plot (synonymous to *chaco rozado*)
toronjal	*toronja* (variant of grapefruit or *pomelo*) orchard
yucal	yucca *(Manihot esculenta)* field

Key messages Folk agricultural landscape categories

- Consultants identified over 30 categories referring to distinct agricultural areas, such as different types of plots and orchards.
- Several terms relate to stages in the cycle from a recently logged forest plot to an established agricultural plot
- Different terms distinguish different stages of fallow plots or barbechos. Barbechos are culturally important landscape units associated with traditional use rights.

5.3 Water-related folk landscape categories

Rivers and streams are important elements of the landscape for Takana people. Major navigable rivers (*ríos*) serve as important transportation routes and as fishing areas for larger fish. Smaller streams in the forest provide drinking water and are a source of smaller fish that are often used as bait for river fish. Small streams or *arroyos* (Fig. 20a) also serve for orientation in the forest and are preferred as efficient travel routes when the riverbed is dry or the water level low.

Fig. 20 Examples of instances for water-related folk landscape categories

Fig. 20a *Arroyo atatal*

Fig. 20b *Curichi*

Takana people believe oxbow lakes or curichis (Fig. 20b) are inhabited by spirits. The water of a curichi is not considered drinkable because of contamination by animals such as tapirs. An area with a lot of curichis is called curichal (area of oxbow lakes) and is generally avoided when traversing the forest. Consultants distinguish 27 landscape categories related to water, ranging from different terms for water bodies as well as terms identifying areas with specific flow patterns (Tab. 4).

Tab. 4 Water-related folk landscape categories

Local Spanish term	Approximate English equivalent
arroyito	small stream
arroyo	stream
boca del río	river mouth
brazo del río	river arm
cañada	streambed
catarata	waterfall
curichal	area with oxbow lakes
curichi	oxbow lake
embocada	river mouth
huarasta	rapids
isla	island
lago	lake
ladera del río	riverbank
manantial	well
orilla del río	riverbank
orillera	riverbank
palizada	pile of driftwood
playa	beach

playón	large beach
pozo	pool
puerto	pier, landing
rebullo	area of burbling water
remanso	eddy
remolino	whirlpool
riachuelo	stream
ribera	riverbank
río	river

Key messages Landscape terms related to agriculture
- Rivers and streams are important elements of the landscape for Takana people that serve for orientation, navigation, as sources for drinking water, and for fishing
- Consultants distinguish 27 landscape categories relating to water, ranging from different terms for water bodies as well as terms identifying areas with specific flow patterns

5.4 Folk topographic categories

Consultants identified 25 different categories that related to topography (Tab. 5), including both concave and convex topographic features, as well as flat surfaces, such as *planicie* (plain, flat surface), or *pampa* (grassland, plain). *Derrumbes* (landslides) are a common feature of the landscape (Fig. 21a).

Fig. 21 Examples of instances for folk topographic categories

Fig. 21a *Derrumbe*

Fig. 21b *Cerro*

The terms *altura* (highland) and *bajío* (lowland) indicate the elevation of the land. Some topographic features have spiritual importance as the dwelling place of spirits, such as *cerros* (mountains, hills, Fig. 21b) that consultants sometimes refer to by toponyms. For instance, the topographic eminence near the town of Rurrenabaque is known as *El Cerro Brujo* (lit. The Sorcerer's Hill). Consultants rarely use the term *montaña*, and prefer the term cerro for topographic elevations in the study area. Lucinda, a Takana consultant explained the conceptual difference between *cerro* and *montaña* as follows:

Cerros are what you see here, there is forest growing on top of them. *Montañas* are bald on top, there is nothing growing there. Montañas are further away, in the highland.

(Field notes, 31.8.2013)

Tab. 5 Folk topographic categories	
Local Spanish term	Approximate English equivalent
altura	height, highland

bajada	descent, slope
bajío	lowland
barranco	embankment
cañada	ravine, gully
cañon	canyon
cerro	mountain, hill
cuchilla	ridge
cueva	cave
cumbre	mountaintop
derrumbe	land slide
desbarrancada	area of land slides
ladera	slope, hillside
llanura	plain
loma	hill
montaña	mountain
pampa	plain
peña	cliff, rock
peña colorada	coloured rock, cliff
peña pelada	bare cliff, bare rock
planicie	flat land, plane (typically of large extent)
planura	flat land, plane (typically used for flat land between the river and higher topographic elevations)

quebrada	mountain ridge
sanjón	gully
serranía	mountain range

Key messages Folk topographic categories

- Consultants identify both concave and convex topographic features, as well as flat surfaces
- 25 categories relate to topographic landscape categories
- Topographic elevations are often named with proper names, and are of spiritual importance
- There is an important conceptual difference between *montaña* and *cerro* based on the land cover of the topographic feature (*montañas* are without and *cerros* covered with vegetation)

5.5 Folk substrate-related categories

Consultants distinguish 13 landscape categories according to substrate or properties relating to the material of the ground (Tab. 6). For instance, sandy areas along the river are called *arenal* (area of sand), derived from the term *arena* (sand) and stony riverbanks are called *pedregal* or *piedral* (Fig. 22a) from *piedra* (stone). A *salitral* is an area with mineral salt licks where different animal species such as White-lipped peccaries come to nibble at the mineral-rich substrate (Fig. 22b). *Salitrales* are culturally important landscape units, because they are believed to be inhabited by spirits. Killing and skinning animals is traditionally forbidden at a *salitral* to avoid any physical and spiritual contamination of the place, thereby ensuring the animals' return.

Other important features in the landscape for hunters are muddy areas called *barreros*, where animals leave their prints in the soft ground. Hunters regularly inspect such places to gather information on the direction of animal movements, for instance of peccary herds.

Fig. 22 Examples of referents for folk substrate-related categories

Fig. 22a *Pedregal*

Fig. 22b *Salitral*

Tab. 6 Folk substrate-related categories

Local Spanish term	Approximate English equivalent
arenal	beach, sandy area
bañero de chanchos	lit. pig's pool (small body of standing water inside the forest where peccaries and other animals take a mudbath)
barreal	area where there are many *barreros*
barrero	area of mud, muddy ground (inside the forest and along rivers)
fangal	area of very fine slush (typically occurring along flowing water bodies)
gredal	area of clay
huellero	area with animal tracks
lodal	area of mud
pedregal	area of stones
piedral	area of stones, rocks
salitral	mineral salt lick
sartenejal	ondulated terrain
secarrón	dry area

Key messages Landscape terms related to substrate

- Consultants distinguish 13 landscape categories according to a specific substrate or properties relating to the material composition of the ground
- A salitral (mineral salt lick) is a culturally important and sacred place believed to be inhabited by spirits.

5.6 Animal habitat

One landscape unit is defined by inhabitance of an animal species. An area with an abundance of *parabas*, the Bolivian name for macaw (DRAE 2001) is called a *parabal*. In the study area there is one large *parabal* in a sandstone cliff along the Tuichi River, where mainly Red-and-Green Macaws (*Ara chloropterus*) nest and raise their offspring, making it a major tourist attraction.

5.7 Linguistic aspects of Spanish landscape terms

In the *Beniano* dialect, as in Standard Spanish, generic landscape terms consist of nouns that end with the Spanish suffix *–al* (plural *–ales*), meaning 'an area of'. This suffix is used in standard Spanish to coin a generic term for a place where the referent of the root of the word is found in abundance (DRAE 2001). This strategy for coining landscape terms is especially common for vegetation (51 generic terms out of 60 ending in *–al*), agricultural terms (14 out of 16), and substrate terms (9 of 13). For example, an area where there were a lot of *balsa* trees is called *balsal* (area of balsa trees). The term *naranja* (orange) is used to form the term *naranjal* (orange grove). This strategy for coining generic landscape terms is also productively used with loanwords. For instance, the Takana term *camururu* (*camururu* tree, *Garcinia madruno*) is the root to coin the vegetation unit *camururusal* (area of *camururu* trees). The elicited landscape vocabulary was therefore a mix of standard and regional Spanish terms, as well as loanwords from different languages.

Although the frequency of loanwords can be assumed to be much larger, at least 14 roots for landscape terms in the contemporary *Beniano* dialect were loanwords (Tab. 7). The etymology of their roots was determined from the literature and existing dictionaries (CIPTA 2011; Pinto Mosqueira 2011).

Tab. 7 Etymology of selected roots of generic landscape terms

Root of landscape term	Origin
asaí	Portuguese loanword from Tupi-Guaraní
ambaibo	Portuguese
atarisi	Takana
bibosi	Chiquitano
camururu	Takana
chuchío	Chané-arawak or Chané
cosorió	Chané
curichi	Chané
marayaú	Guaraní
motacú	Chané-arawak or Chané
paraba	Chiquitano
patujú	Takana
sertenejal	Portuguese
tacuara	Guaraní

The frequency of loanwords was unequal across the different groups of terms. Loanwords were most frequent in vegetation terms, with 12 loanwords (Tab. 7). For water terms, most were standard Spanish, with the exception of *curichi* (oxbow lake, body of standing water inside the forest) that is of Chané origin and *huarasta* (water rapids), with undetermined etymology. The only loanword in substrate terms was *sertenejal* from the Portuguese *sertão*. All topographic terms were standard Spanish.

Apart from nouns, consultants used 3 verbs related to movement in the landscape. The verb *orillar* (to walk along a riverbank) was often used to talk about a jaguar's movements, for instance: 'Anoche ví el tigre *orillando* (yesterday night I saw the jaguar walking along the riverbank)'. The verb *playonear* referred to walking along a *playón* (a large stretch of beach). The verb *cuchillar* was derived from *cuchilla* (ridge) and means to walk along a ridge. Often, hunters used this verb when describing their hunt. Walking along a ridge their aim was to perceive smells and noise from animals on both sides of the ridge and to locate, for instance, a troop of White-lipped Peccaries.

Key messages Linguistic aspects of Spanish landscape terms

- In the Beniano dialect, as in Standard Spanish, generic landscape terms consist of nouns ending with the Spanish suffix *–al* (plural *–ales*), meaning 'an area of'.
- 14 roots for landscape terms in the contemporary Beniano dialect were loanwords from languages such as Portuguese, Guaraní, Chané and Chané-Arawak
- Loanwords were common for vegetation terms, but all topographic terms were standard Spanish.

5.8 Comparison of folk vegetation categories with scientific classification

Common to both the folk categorisation and the scientific classification was the use of indicator plants for identifying vegetation units (Tab. 8). Plant species that were visually salient or dominant, as well as easily recognisable were commonly used in both systems. For instance, the folk category *charral* was identified by the *charo* plant (*Gynerium sagitattum*), which was also an indicator species for the botanical identification of 'Pioneer riverine reed area of *Gynerium sagittatum* on sandy soils' (Fuentes 2005).

The local system relied predominantly on indicator plants for identifying and naming vegetation units. In all three investigated languages, the terms of vegetation units were based on the name of the indicator plant. The scientific system was based on phrases consisting of a general classification of the vegetation type (e.g. pioneer riverine vegetation), the edaphic regime (e.g. sandy soils), and may or may not include one or more indicator species.

The level of differentiation varied between the two systems, albeit not consistently. In some cases, the folk vegetation categories were more differentiated. For instance, in the local system of landscape categories, two terms distinguished areas with distinct growth forms of *Gynerium sagitattum*. One form grew on sandy soils called *charo*, forming the vegetation unit of a *charral*. The depauperated growth form on oligotrophic soils was called *charillo* and formed a *charillal*. These two growth forms of the same species were not distinguished in the scientific botanical classification.

Furthermore, patches of important trees such as *evanto* were termed *evantal* in the folk vegetation categorisation, and were classified more generally as 'Amazonian forest' in the scientific botanical classification (Tab. 8).

Tab. 8 Examples of local and scientific botanical classification categories

Local classification	Scientific botanical classification
ambaibal	Different pioneer forests dominated by *Cecropia* spp.
atarisal	Reasonably well-drained herbaceous Amazonian forest understory with *Cyclopeltis semicordata*
barbecho nuevo	Secondary Amazonian forest usually on flat areas with humid soils
barbecho viejo	Amazonian forest with humid soils
cahuaral	Pioneer riverine vegetation with *Tessaria integrifolia*
charral	Pioneer riverine reed area of *Gynerium sagittatum* on sandy soils
charillal	Pioneer riverine reed area of *Gynerium sagittatum* on sandy soils
evantal	Somewhat poorly drained Amazonian forest
japainal	Herbaceous understory of seasonally flooded Amazonian forest (várzea) with *Heliconia episcopalis*
jatatal	Well-drained Amazonian forest with *Geonoma deversa*
marayausal	Poorly drained to seasonally flooded Amazonian forest with *Bactris concinna*
marfilsal	Palm forest with *Phytelephas macrocarpa*

monte alto	Reasonably well drained Amazonian forest Poorly drained Amazonian forest Várzea
motacúsal	Poorly drained Amazonian forest with *Attalea phalerata*
tacuaral	Bamboo shrubbery with *Guadua weberbaueri*
vizal	Palm forest in marsh area with *Mauritia flexuosa*
yupural	Pioneer riverine shrubbery on pebble beach with *Calliandra angustifolia*

The scientific classification on the other hand differentiated distinct types of old growth forest ('Várzea forest', 'Amazonian forest with well drained or poorly drained soils') all referred to as *monte alto* in the folk categorisation (Tab. 8).
The spatial extents of the underlying referents for the folk categories (i.e. the size of the actual landscape units the terms refer to) were typically at fine spatial granularities and could be perceived from a single point of view. The scientific classes referred to spatial units that extent over larger areas and could not be perceived from a single vantage point.

5.8.1 Practical implications

Some differences between scientific and folk classification are based on different degrees of differentiation. However, the empirically documented discrepancies point to more fundamental differences at a more conceptual level. An account of Takana consultant Aurelio illustrates this: Aurelio lives in an area where the indigenous territory and the Madidi protected area overlap. He is upset about the fact that scientists often do not seem to recognise old fallow fields or *barbechos*, and instead classify

them as *primary rainforest*. These areas were mapped as undisturbed primary rainforest and following the conservation logic, were then assigned a high conservation value by protected area management that prohibits agricultural use by indigenous people. When Aurelio wanted to clear a *barbecho* his grandfather had once cultivated and since then had been left fallow, protected area staff informed him that this area consisted of primary rainforest and he was not allowed to clear the plot. Aurelio pointed to a patch of forest (Fig. 23) and said:

They think it is jungle and they want to protect it. But this is not the jungle, this is my barbecho!

(Field notes, August 2012)

Fig. 23 Example of an area indigenous people classify as *barbecho* and scientists as *primary rainforest*

Rapid botanical assessments of these areas by scientists are based on the dense herbal layer and large trees that were left standing by the Takana (e.g. *Ficus* spp.). Furthermore, patches of *barbecho* are small in extent, typically one hectare, and interspersed with undisturbed forest, which makes their detection more improbable during rapid field assessments. The data classifying such areas as 'primary rainforest' is then represented in the protected area's geographic information system and if local users such as Aurelio want to clear forest on these plots for agricultural use, management staff will check the GPS coordinates of the plots. As the coordinates fall within an area of high protection status, if a proposal for the agricultural plot was to be submitted, it will likely be declined. If people already cleared the plot, they run the risk of being fined.

This study highlights how such management practices of the protected area are at odds with the traditional notion of land ownership for the Takana, in which a *barbecho* is a fallow field set aside for potential future use with associated rights derived from the lineage of the person who first cleared it. The Takana distinguish *barbechos* from primary forest by their species composition (*Cecropia* spp., *Ochroma pyramidale*) and relative species abundance, growth form of certain plants (e.g. *Attalea phalerata*) and colour of the vegetation resulting from previous agricultural use. This example highlights how differences between categorisations are not merely interesting curiosities. Such differences may have important consequences for how areas are classified and ultimately, how they will be managed.

Key messages Comparison of folk vegetation categories with scientific classification

- Common to both the folk categorisation and the scientific classification was the use of indicator plants for identifying vegetation units
- Plant species that are visually salient or dominant, as well as easily recognisable are commonly used in both systems

- The scientific system is based on phrases consisting of a general classification of the vegetation type, the edaphic regime, and may or may not include one or more indicator species.
- Observed onceptual differences between folk and scientific categorisations have important consequences for how areas are managed

I put the landscape pictures where they belong,
so that what you can find close together
in the landscape is close
Consultant inTumupasha,
August 2013

Chapter 6
Hierarchy and drivers of folk landscape categorisation

This chapter deals with RQ3: *How is the folk categorisation of landscape organised and what are landscape categorisation drivers?* First, the results for the hierarchy of the folk landscape categorisation are presented, followed by the factors that were identified as potential drivers for the documented categorisation.

6.1 Hierarchy of folk landscape categorisation

As no indications on how to sort the photographs were provided in the sorting exercise, consultants chose their own form of sorting. All consultants chose to place photographs next to each other on the provided brown wrapping paper. Photographs belonging together in a group were arranged more closely together on the sheet. Many of the groups of photographs had no clear boundaries. The hierarchies emerging from the sorting exercies were flat, and most consultants identified two hierarchical levels. Certain photographs were considered members of several groups and consultants placed them between two groups of photographs, thereby forming a continuous surface of photographs that indicate the transition from one landscape type to another. Consultants considered some photographs more typical examples of a group than others, which consultants expressed by placing these photographs at the center, while placing less typical members towards the outside of a group.

6.1.1 Hierarchy of folk landscape categories and typical examples

In total, consultants formed 20 groups of landscape photographs, with each consultant forming between 3 – 13 groups (arithmetic mean = 6.7 ± 2.8, n = 9). Eight out of nine consultants formed a group they named *monte alto*, followed by groups named *orilla, río, chaco* and *barbecho* identified by 6 consultants (Tab. 9).

Tab. 9 Labels for groups of landscape photographs

Spanish term	English gloss	Number of consultants
monte alto	rainforest	8
orilla / ribera / ladera (del río)	riverbank	7
barbecho	fallow field	6
chaco	agricultural field	6
río	river	6
pedregal / piedras / rocas	stony area / stones / rocks	4
bajío	lowland	3
derrumbe	landslide	3
cerro	hill	2
salitral	mineral lick	2
playa (del río)	beach	2
altura	high land	1
barranco	escarpment	1
curichal	area of oxbow lakes	1

marayabusal	area of *marayabú* plants	1
serranía	mountain range	1
tacuaral	area of *tacuara* plants	1

The labels for groups of photographs are taken to represent a higher categorisation level than the lables for the photographs or members of a group. The following section presents the most commonly mentioned higher-level categories with examples of members that three or more consultants selected as typical examples.

For the category *monte alto*, consultants chose as typical photographs *jatatal* (area of *jatata* palms), *atarizal* (area of ferns) or *behucal* (area of lianas) (Fig. 24).

Fig. 24 Typical landscape photographs as members of the category *monte alto*

Fig. 24a

Fig. 24b

Fig. 24a *jatatal*
Fig. 24b *atarizal*
Fig. 24c *behucal*

Fig. 24c

For the category *orilla* consultants selected photographs as typical that showed landscape elements such as *charral* (area of *charo* plants), *yupural* (area of *yupura* plants) and *playa* (beach) (Fig. 25).

Fig. 25 Typical landscape photographs as members of the category *orilla*

Fig. 25a

Fig. 25b

Fig. 25a *charral*
Fig. 25b *yupural*
Fig. 25c *playa*

Fig. 25c

In the category *chaco*, typical examples were plantations and agricultural plots, such as *yucal* (yucca field), *platanal* (banana plantation) and *pastizal* (meadow) shown in Fig. 26.

For the category *barbecho*, typical examples were *barbecho medio* (intermediate fallow plot, Fig. 27a) and *barbecho viejo / barbecho alto* (old fallow plot, Fig. 27b). More recent fallow plots were not considered typical for this category. They were often grouped as *chacos*, where consultants mentioned them as untypical examples.

Fig. 26 Typical landscape elements as members of the category *chaco*

Fig. 26a

Fig. 26b

Fig. 26a *yucal*
Fig. 26b *platanal*
Fig. 26c *pastizal*

Fig. 26c

Fig. 27 Typical landscape elements belonging to the superordinate category *barbecho*

Fig. 27a *barbecho medio*

Fig. 27b *barbecho viejo*

Although the Bala mountain range was visible from the study area and was represented in photographs, consultants only infrequently made groups containing mountains, hills or other land-

forms, and more often placed photographs of landscape as 'untypical members' at the border of different groups. Some consultants made groups with only one member, which were often culturally important landscape units, such as mineral salt licks and vegetation types with specific uses.
In the sorting exercise, there were considerably more partonomic than taxonomic relationships. For instance, consultants explained how landscape elements such as *behucal* were *within* the rainforest (*'un behucal está dentro del monte alto'*) but they *were not* rainforest. One of the few taxonomic relationships was, for instance, that consultants considered a maize field or a rice field as a type of *chaco* (agricultural field).

Key messages Hierarchy of folk landscape categorisation

- Consultants formed between 3 – 13 groups of photographs. The terms consultant used to name these groups are taken to represent categories at a higher hierarchical level
- Some photographs were considered more typical members for a group of photographs than others
- The resulting hierarchy of folk landscape categories was flat, with usually 1 or 2 levels of organisation

6.2 Drivers for folk landscape categorisation

Different factors or so-called drivers may influence folk categorisation. The following sections investigate different potential drivers for folk landscape categorisation.

6.2.1 Semantic links

As a first assumption I examined whether the higher level folk categories corresponded to broad thematic areas such as 'vegetation' or 'water'. Members of such categories would be characterised through strong semantic links given by a high number of shared properties. However, such semantic links did not appear to be important categorisation drivers. For instance, there was no

folk category corresponding to 'vegetation'. Instead, landscape units dominated by vegetation were distributed in all five common higher-level folk categories except *río* (river). Although between 5 and 7 consultants grouped the vegetation units *jatatal* (area of *jatata* palms), *atarizal* (area of ferns) and *behucal* (area of lianas) together, none of the consultants grouped together a *behucal* with photographs of a *charral* (area of charo plants), or a *jatatal* with a *charral*.
Two folk categories *río* (river) and *orilla* (riverbank) mainly contained water elements. The category *orilla* (riverbank) also contained embankments, beaches and riverine vegetation types. However, not all photographs containing water were categorised as members of *río* or *orilla*. For instance, photographs showing a *curichi* (oxbow lake) were consistently grouped as belonging to *monte alto* (rainforest). Consultants mentioned that oxbow lakes were 'left behind' by the river, thus highlighting a process-based approach to landscape categorisation. This semantic link between oxbow lakes and rivers notwithstanding, consultants still categorised oxbow lakes as members of the category rainforest. A consultant explained this choice as follows:

The *curichi* belongs to the rainforest, because the rainforest contains elements with water such as *curichis*.

In this case, the topological relation of containment seemed to be a more important driver for categorisation than the semantic link of water between oxbow lakes and rivers.

6.2.2 Utility

The five most commonly mentioned higher level categories had specific uses for local people. For instance, rainforests are places where people go for hunting and gathering construction material, rivers are used for navigation and fishing, and agricultural fields are used to produce food. Landscape categories with similar uses were often grouped together, such as a yucca field and a banana plantation used for food production. However, none of the consultants mentioned utilitarian aspects as reasons for categorisation. Furthermore, utility as a single driver was not able to explain the observed categorisation. For example, the vegetation types *charral* and *jatatal* were both sources of construction material, but none of the consultants grouped them together. In interviews, consultants explained that, because *charrales* are found along rivers, they belong to the group of 'riverbank'. Consultants grouped photographs showing a *charral* together with other photographs showing vegetation of riverbanks. For instance, eight consultants grouped together the photographs of a *charral* and a *cahuaral* (area of *cahuara* plants, a riverine vegetation unit). In contrast, eight consultants grouped photographs showing a *jatatal* together with photographs of forest elements and labeled the group as *monte alto* (rainforest).

6.2.3 Degree of human interaction with landscape

Three consultants mentioned the degree of human interaction as their criterion for distinguishing between *monte alto* and *chaco*. Rainforests were seen as areas with little human interaction, and agricultural fields and plantations as anthropogenically modified areas previously covered with rainforest. The category *barbecho* (fallow plot) took an intermediate stand between rainforest and agricultural field. Its classification depended on the time the plot had been left fallow: new fallow plots where the last human interaction had taken place less than five years ago were often categorised as *chacos*. Old fallow plots not cultivated for five or more years were categorised as *monte alto*. Several consultants explained they had arranged the groups of *monte alto* and *chaco* next to each other, with photographs of the fallow plot at the 'border' between these groups. With this arrangement they aimed to illustrate how for them, *barbechos* constituted a transitional state in the succession from agricultural field to forested area. However, the degree of human interaction did not explain the resulting differentiation between rainforest and rivers, for example.

6.2.4. Topological relations – how the actual landscape influences categorisation

Consultants mentioned the spatial arrangement and properties of the actual landscape units as grouping criteria. For example, one consultant used elevation as a criterion, so that the groups reflected an increasing elevation from the river (*bajío*, low area) to the hilltops (*altura*, high area). Another consultant explained that in the sorting exercise, he rebuilt the landscape with the photographs, putting them *'where they belong, so that what is close in the landscape is close'*, using topology and position of features in the landscape as a criterion for categorisation (Fig. 28). This consultant explained that the arrangement of photographs 'as they are in the landscape' is the best way of organising the photographs in order to learn about their properties, uses and where to locate certain landscape types in the environment. Importantly, this consultant was unfamiliar with the locations shown in pictures, and he refered to the arrangement of types of landscapes you would typically find in his area, he did not recreate the location of specific places in the sorting exercise.

Fig. 28 Arrangement of landscape photographs according to landscape in a sorting exercise

Key messages Drivers for landscape categorisation

- Semantic links did not appear to be important categorisation drivers.
- The five most commonly mentioned higher level categories had specific uses for local people, but none of the consultants stated to have used utilitarian aspects as reasons for categorisation.
- Consultants mentioned the spatial arrangement and properties of the actual landscape units as criteria, for example, grouping photographs of landscape units together that occurred close together in the actual landscape.

A stone is a stein is a rock is a boulder is a pebble
Ernst Hemingway,
For Whom the Bell Tolls, 1940: p. 289

Chapter 7
Folk landscape categories in Takana and Mosetén

In this chapter, I first briefly introduce how the two linguistically unrelated languages Takana and Mosetén grammaticalise landscape, before illustrating the results on the elicited folk landscape categories, which consisted of 181 entries for the Takana and 189 for the Mosetén language.

7.1 Grammaticalisation of folk landscape categories in Takana and Mosetén

Takana mostly uses nominal forms for landscape categories. A majority of terms for landscape categories in Takana include a ‘place-marker’, such as the Takana term *judhe* often contained in a landscape term. Derived from the noun *etijudhe* (place, location), *judhe* can generally be added both to verbs and nouns. For instance the verb *s’a* (to lie down) in combination with the place-marker becomes *s’a judhe*, the Takana term for a readymade bed or literally ‘a place to lie down’. Applied to landscape terms, *judhe* is added to plant or substrate terms to form a landscape term, such as *tumi judhe* (area of *motacú* palm trees) or *rutu judhe* (area of mud).

In addition to the term *judhe* as a place-maker, Takana consultant Leonardo Marupa highlighted the use of the terms *tipa, dhu* and *judhe* to distinguish different sizes of places, especially concerning patches of specific plant species. *Tipa* refers to small areas with a few plants, such as in the expression *madhata tipa* (an area with some *jatata* plants). *Dhu* can be used to refer to mid-sized patches in the landscape such as *madhata dhu* (a patch of

jatata plants) and *judhe* is used to coin a term for an entire area of *jatata* plants, referred to as *madhata judhe*. In this thesis, based on the suggestion of consultants, I use the term *judhe* for reporting Takana landscape terms, because this is most commonly used and is closest to describing parts of a landscape.

In Mosetén, the nominaliser -*dye’* is predominantly used to coin landscape terms. Adding -*dye’* to nouns changes their meaning to place (Sakel 2004, p. 95). For instance, adding -*dye’* to the plant name *shɨrɨ* (*charo* plant, *Gynerium sagittatum*) forms the vegetation term *shɨrɨdye’* for an area of *charo* plants. The nominaliser -*dye’* has a range of different uses in Mosetén and can also be used to coin a term for a place where an action is performed, such as *wirakdye’* (place of the threshing). The Mosetén landscape categories reported in this thesis use the nominaliser -*dyei’*, because Clemente Caimani, one of the consultants for Mosetén who was involved in the documentation of Mosetén language and culture (e.g. CRTM 2010), suggested it as the most appropriate form.

7.2 Some folk vegetation categories in Takana and Mosetén

The elicited folk vegetation categories consisted of 66 categories for Takana and 56 categories for the Mosetén language. Landscape categories in the two indigenous languages did not always neatly match on the Spanish landscape categorisation. Sometimes Mosetén and Takana consultants did not find an equivalent Spanish term for an indigenous concept, but had to explain and describe it in Spanish. For example, in Takana, the category *djanata* was based on the edaphic regime of a forest area (a wet, badly drained forest), for which there was no similar lexical expression in the local Spanish dialect. Another example is that there was no Spanish landscape category that expressed the concept of the Mosetén *kujya’* (unknown place in the forest), although it could be described in Spanish as *'un lugar desconocido dentro del monte alto'*.

The Takana and Mosetén landscape categories often referred to finer granularities of differentiation than the Spanish categories. For instance, Mosetén consultants stated there was no equivalent for the Spanish term *bejucal* (liana thicket), because there was no general term for *bejuco* (liana). In Mosetén, there were terms for different types or species of liana: *bimaktyi'/ biy'tyi'* for the liana also known as *mata palo* in Spanish, *oweto'* for *uña de gato* in Spanish, and several unidentified ones such as *chhïyïjyïy', dyinkäwä', idyijtse, kayaya, öjme'ro, tiribi' durtyi',* and *totoy*. The Mosetén term *kayayadyes* for liana thicket listed in Table 10 was the term for a specific liana that was commonly found in the forest, which was why Mosetén consultant Clemente Caimani selected it as the best Mosetén equivalent for liana thicket. Similarly, there was no equivalent in Mosetén for the Spanish term *palmar* (stand of palm trees), because there was no general term for palm, but names for many different palm species (e.g. *jajrɨ, mañere, wuij, mana'i, jarɨjki', tyɨtyɨ'ra*) that, combined with the nominaliser, each form a different vegetation category.

In Takana, there was a higher lexical differentiation between forests with clear and with dense understory than in the Spanish dialect, where *monte alto razo* (forest with clear understory) and *monte alto tupido* (forest with dense understory) were distinguished. For Takana consultants, this distinction was important in order to communicate about forest that needed to be traversed during hunting or plant gathering. In Takana three categories were elicited for forest with clear understory (*puruma ejije chaerarajiji, puruma ejije cherarata, puruma ejije shaipatia*), and three for forest with dense understory (*puruma ejije d'ejedha eni, puruma ejije d'ipi d'ipi, puruma ejije madha madha*). However, different speakers used different expressions, and I could not determine if and how these categories differed semantically from each other. Mosetén consultants also distinguished forest with clear understory (*dursi' duru' sajras*) from forest with dense understory (*dursi' duru' tsɨpsis*). In Mosetén, the expression *jumdyei'* (forest where the wind blows) was also used for forest with dense understory, but includes the notion of wind that can be perceived on the skin and heard from the leaves rustling.

Both Mosetén and Takana identified different patches of plants that were used as construction material, food, medicine, or were important spots for locating animals. Particularly good hunting spots below fruit trees, for example, were referred to in the Mosetén expression *wai'jodyeya' wush durus* in. However, as these expressions were longer and more complex than the common vegetation terms used, it was sometimes difficult to decide whether to include such expressions as part of the established vocabulary or whether they were rather *ad-hoc* descriptions of a concept. In such cases, the decision to include an expression or term was based on whether several speakers had used similar expressions when describing the same phenomenon, although in linguistic terms, further analysis would be needed to decide whether these expressions were descriptive or established generic landscape terms.

Tab. 10 Some folk vegetation categories in Takana and Mosetén

Indigenous terms	Approximate English equivalent
Takana terms	
adhune judhe	stand of a type of *chonta* palms
adja dja judhe	stand of *picapica* plants
akid'a judhe	area of spiny or thorny plants
akidju judhe	area of *manzana del monte* trees

atarisi judhe	stand of *atarisi* plants
awadha japaina judhe	scrubland
bereu kid'a judhe	stand of *uña de gato* liana
bes'a bes'a	swamp, wetland
bid'i judhe	stand of *balsa* trees
bijaja judhe	stand of *palma real* palms
bue judhe	stand of *charo* plants
buwi judhe	stand of *chonta* palms
cahuara judhe	stand of *cahuara* plants
camururu judhe	stand of *camururu* trees
chachichira judhe	stand of *cachichira* trees
chawara judhe	stand of a type of *chonta* palms
chuchi chuchi	area with a lot of lianas
djanata	type of wet forest
djiwapiu judhe	stand of *cosorió* trees in the forest
dyadya judhe	feeding place for animals
ejije	jungle
esipena	swamp, wetland
ewid'a eki judhe	stand of asaí palms
ewid'a judhe	stand of *palma real* palms
jama judhe	stand of *chaquillo* trees
jamemumemutiji	area with a lot of lianas
japa judhe	stand of *patujú* plants
japaina judhe	stand of *japaina* plants

jas'aju judhe	stand of *achachairú* trees
jiruma judhe	area of sugarcane plants
junu bita judhe	stand of *chaimarú* lianas
junu judhe	stand of lianas
kipabi judhe	stand of *gabetillo* trees
kuabadhu judhe	stand of *cedro* trees
kuatsui judhe	stand of *cosorió* trees along the river
madhata judhe	stand of *jatata* palms
maja judhe	stand of fig trees
maju judhe	stand of *majo* palms
makuri judhe	stand of *majillo* palms
miti judhe	stand of *miti* lianas
mue judhe	stand of *chima* palms
mui judhe	stand of *tacuara* plants
nas'a turudhu judhe	stand of pacay trees
pakicha judhe	stand of *mara* trees
papi junu judhe	stand of *papi junu* lianas
pena judhe	stand of *penena* plants
puruma ejije	forest
puruma ejije chaerarajiji	forest with clear understory
puruma ejije cherarata	forest with clear understory
puruma ejije d'ejedha eni	forest with dense understory
puruma ejije d'ipi d'ipi	forest with dense understory
puruma ejije madha madha	forest with dense understory

puruma ejije shaipatia	forest with clear understory
s'iki judhe	stand of *cortadera* plants
s'iuru judhe	stand of *charillo* plants
s'utere judhe	area of vanilla plants
tadhe dhewe	stand of *momóqui* trees
tawa judhe	stand of *ambaibo* trees
tsipa judhe	stand of *marayaú* palms, also *marayabú*
tsumiu judhe	stand of *chumiri* trees
tumi judhe	stand of *motacú* palms
tuwanu judhe	stand of *copa* palms
umere judhe	stand of *marfíl* palms
yapa	dense vegetated area with lianas
yatsi s'u tiujiji wiri kuana	scrubland, shrubland
yuruma wana judhe	stand of *evanto* trees
Mosetén terms	
araradyei'	stand of *picapica* plants
bajedyei'	stand of *marfíl* palms
bañedyei'	stand of *tacuara* plants
bɨrɨrɨkyei'	scrubland
bɨwedyei'	stand of *achachairú* trees
bɨwedyei'	stand of *camururu* trees
wijridyei'	stand of *pachuba* palms
cho'ejwedyei'	stand of *patujú* plants

dursi' duru'	forest
dursi' duru' sajras	forest with clear understory
dursi' duru' tsɨpsis	forest with dense understory
dyɨñidyei'	stand of *japaina* plants
dyotodyei'	stand of *chumiri* trees
i'tyajmadyei'	stand of *mara* trees
ibamtyadyei'	stand of *evanto* trees
iyo'podyei'	stand of *yupura* plants
jajrɨdyei'	stand of *majo* palms
jarɨjkidyei'	stand of *marayaú* palms, also *marayabú*
jijpadye'	grassland, flat area (also inside the forest)
jiwindyei'khan	stand of *cortadera* plants
joko'kodyei'	area of vanilla plants
jumdyei'	forest where the wind blows (with clear understory)
käjñeredyei'	stand of *balsa* trees
kajpadyei'	stand of *cosorió* trees
kajtyafadyei'	stand of *jatata* palms
kayayadyei'	stand of a type of *bejuco de monte* lianas
kujya'	unknown place in the forest
manaidyei'	stand of *motacú* palms
mañeredyei'	stand of *asaí* palms

möwäidyei'	stand of a variety of *ambaibo* trees
ñerkadyei'	area with a lot of lianas
ojdyodyei	stand of *copa* palms
owetodyei'	stand of *uña de gato* liana
parɨ'	shrubland
payadyei'	area of *patujú* plants
sajradyei'	forest where the wind blows, with clear understory
sewin'dyei'	stand of *sauce* plants
shabadyei'	stand of *pakai* trees
shabashabadyei'	stand of *atarisi* plants
shesherenadyei'	stand of *cachichira* trees
shibodyei'	stand of *chonta* palms
shɨrɨdyei'	stand of *charo* plants
sijtyädyei'	stand of *cahuara* plants
simadyei'	stand of fig trees
siyämödyei'	stand of *cedro* trees
tijtëtsodyes	stand of *momóqui* trees
tsɨpsis	dense vegetated area
tsonadyei'	stand of *ambaibo* trees
tsönäjdyei'	stand of a variety of *ambaibo* trees
tyɨtyɨ'radyei'	stand of *palma real* palms
wai'jodyeya' wush durus in	feeding place of animals below fruit trees

wai'yo'ya'bɨbɨj	feeding place for animals below a fig tree
wajbäsondyei'	stand of *gabetillo* trees
wojpinadyei'	stand of *penena* plants
wui'dyei'	stand of *chima* palms
yɨdyidyei'	area of spiny or thorny plants

Key messages Folk vegetation categories in Takana and Mosetén

- The categorisation of landscape elements in the two indigenous languages did not always neatly match on the Spanish landscape categorisation.
- Both Mosetén and Takana identified different patches of plants that were used as construction material, food, medicine, or were important spots for locating animals.
- Takana and Mosetén landscape terms often referred to finer granularities of differentiation than Spanish terms.
- For general vegetation terms such as 'liana thicket' there was no equivalent in the two indigenous languages, because there is no general term for 'liana', but rather terms for different varieties and species of liana that are used as roots to coin generic landscape terms.

7.3 Some folk agricultural categories in Takana and Mosetén

Both Mosetén and Takana distinguish between different agricultural areas based on the distinction of different crops and fruit grown in these plots (Tab. 11). The documented vocabularies for agricultural areas consist of 34 folk agricultural categories for the Takana language and 39 for Mosetén. In Mosetén, 5 categories refer to plots where distinct banana varieties are grown (*doninikajdyei', dyiñeyodyei', kujrurusdyei', rapashdyei',tɨkbɨbɨsdyei'*). The scientific names for these varieties and species remained undetermined, because in compliance with the research agreement with both Takana and Mosetén indigenous councils, I did not collect specimens and was unable to determine the scientific name from plants in the field. For some crops, there were no indigenous terms, and the Spanish term was used as a loanword. For example, in Takana consultants used the expression *frijol judhe* (lit. area of beans) for a beanfield, where *frijol* is the Spanish word for 'bean'. In Mosetén, a similar example is the expression *toronjadyei'* (grapefruit orchard), where *toronja* is the Spanish expression for grapefruit.

Both Mosetén and Takana had lexical expressions for the concept of an agricultural field or plot (a *chaco* in the local Spanish dialect). In Takana, the distinctions made between different stages in the agricultural cycle were *te kejiji* (logged plot), *te shatse eji* (cleared plot), *te tiujiji* (burnt plot), and *te ajiji* (plot ready for planting). These distinctions were comparable to the distinction in the Spanish dialect. The category *te wibuji* (agricultural plot with a pointed angle), however, was distinguished based on shape, which was not made by Spanish-speaking consultants. In Mosetén, the categories *kïyjëdyë'* and *kïjödyë'* were dialectal variants (Santa Ana and Covendo dialects) for the concept of an agricultural plot, where different stages were distinguished. For example, in the Santa Ana dialect the expressions used were *kïjödyë' phaksi'* (logged plot), *kïjödyë' fajraksi'* (cleared plot), and *kïjödyë' jawaksi'* (burnt plot).

In both Takana and Mosetén, fallow plots (*barbechos* in the *Beniano* Spanish dialect) were important concepts that were lexically expressed. In Takana, for example, *teini* (fallow plot) was distinguished according to age, and height of plants, respectively, into *teini eichakua* (new fallow plot), *teini emud'u* (intermediate fallow plot), *teini edji* (old fallow plot), and *teini baudha* (old or literally 'high' fallow plot). In Mosetén, the distinction is also based on the height of plants, from which Mosetén speakers would infer the time since the plot has been left fallow: *kɨm ichi'kis* (low or new fallow plot), *kɨm mɨi'sis* (low or new fallot plot), *kɨm jam moches* (intermediate fallow plot), *kɨm mochches* (high or old fallow plot), *kɨm poromas* (high or old fallow plot). Thus, in all

three languages, different stages of fallow plots are lexicalised, and the distinction is based on the height of plants as an indication of the time the plot has been left fallow.

Tab. 11 Some folk agricultural categories in Takana and Mosetén

Indigenous terms	Approximate English equivalent
Takana terms	
arus'u judhe	rice field
buwe judhe	guava orchard
chipa kashi judhe	banana plantation (unknown variety)
d'ije judhe	maize field
eja ja judhe	fruit orchard
frijol judhe	bean field (from Spanish *frijol*, bean)
kashi djere judhe	banana plantation (*guineo colorado*)
kashi judhe	banana plantation
kuawe judhe	yucca plantation
manga judhe	mango orchard
mura judhe	cacao plantation
naras'u judhe	orange orchard
nas'a eicha kua edjeuti	first growth plantain field
nas'a judhe	plantain plantation
nas'a kashi judhe	banana plantation

nutsa judhe	grazing area, pasture
puruma te	agricultural plot planted after the first clearing
purutu judhe	bean field (from Spanish *poroto*, bean)
s'aipatia	clear area
sayu judhe	pineapple plantation
te	agricultural plot (*chaco*)
te ajiji	agricultural plot
te kejiji	logged plot
te shatse eji	cleared plot
te tiujiji	burnt plot
te wibuji	agricultural plot with a pointed angle
teini	fallow plot
teini baudha	old (lit. high) fallow plot
teini edji	old fallow plot
teini eichakua	new fallow plot
teini emud'u	intermediate fallow plot
teini judhe	area of fallow plots
tumi judhe	stand of *motacú* trees
tumi kashi judhe	banana plantation (*motacucillo*)
Mosetén terms	
arroshdyei'	rice field
ashäshäjdyei'	lemon orchard

bɨrɨrɨk	meadow, grazing area
chhɨi'bɨi'	clear area
cho'ratidyei	cacao plantation
chokoratidyei'	cacao plantation
doninikajdyei'	plantation of *guineo motacucillo*
dyiñeyodyei'	*guineo* plantation
fajrakdye'	cleared plot
jam mensi' kɨm	low fallow plot (Covendo variant)
jojoi'si pére	first growth plantain field
katsijdyei'	field of dark *hualusa* (a tuber)
kijödyë	agricultural plot
kijödyë'	agricultural plot (Santa Ana variant)
kijödyë' fajraksi'	cleared plot
kijödyë' jawaksi'	burnt plot
kijödyë' phaksi'	logged plot
kɨm	fallow plot
kɨm ichi'kis	low fallow plot (Santa Ana variant)
kɨm jam moches	intermediate fallow plot
kɨm mɨi'sis	new fallow plot
kɨm mochches	old (lit. high) fallow plot
kɨm poromas	old fallow plot, fallow plot with high plants
kɨmedyëi' khan	area of fallow plots

kiyjëdyë'	agricultural field (Covendo variant)
korisdyei'khan	bean field
kujrurusdyei'	*guineo seda* plantation
manaidyei'	stand of *motacú* trees
mangodyei'	mango orchard
marakhadyei'	orange orchard
merikhedyei'	pineapple plantation
o'yidyei'	yuca (*Manihot esculenta*) field
pe'redyei'	plantain plantation
pofi-äshäbä'	papaya orchard
rapashdyei'	plantation of *guineo isleño*
säkäkdyei'khan	fruit orchard
tɨkbɨbɨsdyei'	plantation of *guineo mata borracho*
toronjadyei	grapefruit orchard (from Spanish *toronja*)
tyärädyei'	maize field

Key messages Folk agricultural categories in Takana and Mosetén

- Both Mosetén and Takana distinguish between different agricultural areas, based on the distinction of different crops and fruit grown in these plots.
- In some cases, the lexical distinction between plots where different types of crops or fruit are grown had were more differentiated than in the local Spanish dialect.

7.4 Some folk hydrological categories in Takana and Mosetén

In Takana, water courses are distinguished based on size, intensity of the current, and on water level (Tab. 12). Furthermore, the Takana language has lexicalised expressions for rivers with a particular sound, and visual aspects. Different sizes of water courses are expressed as *ena ai* (river), *ena baki* (river, stream), *ena baki chidhi* (stream, small stream). Although Takana, like Spanish, distinguishes water courses (also) based on size, Takana terms do not neatly match the Spanish conceptualisation of *río* (river), *arroyo* (stream), and *arroyito* (small stream, streamlet). Takana speakers mentioned that, for example, the Takana term *ena baki chidhi* referred to as 'something like an *arroyo*' to clarify that Takana and Spanish terms were not simply interchangeable. In Takana, water courses are furthermore differentiated based on water level, which relates to the navigability of the watercourse. Consultants mentioned that these distinctions were important for Takana who, until the appearence of motorised boat transport on the Beni River, navigated rivers on wooden rafts called *balsas*. The Takana term *ena baki as'e taji* refers to watercourses with high water level that were navigable and the term *ena baki as'e taji mawe* to watercourses with low water levels that make them unnavigable. A river with high water level (e.g. during floods) was referred to as *enai ai tiputetipute epus'a*, and a river with a strong current as *ena ai jubidha*. A river with a strong current that made a lot of noise (because it was transporting a lot of stones) was referred to as *ena ai epas' ereti jubidha*. A visual distinction was made for water courses with crystalline water that were referred to as *ena kuarekuare* (reflexion of light on the water, clear river). The lexicalisation of different types of water courses in Takana (Tab. 12) into 43 folk hydrological categories was thus more differentiated than in the local Spanish dialect where 28 folk categories were documented (Tab. 4).

In Mosetén, 42 elicited folk categories for watercourses were identified. In Mosetén the terms for different sizes of water courses are *ojñi' dursi'* (river), *jinak* (stream), and *jinak ichɨkis* (small stream). There are no elicited terms referring to the navigability of a river, but the term *shewekya'* refers to a stream or river with a water level so low it can be crossed on foot and *chi'* to a shallow place within a (deeper) river.

In both Takana and Mosetén, different expressions were elicited that distinguish parts of water courses based on flow patterns. In Takana, the expressions *ena ekuarareneti* and *ena rujuruju* both refer to an area with upwelling or bubbling water in a river. A whirl in the river is called *ebarereneti twathuthu*. Takana consultants considered these spots important for fishing, but as dangerous for boat navigation. Furthermore, areas of standing water in a flowing body of water are called *ebarereneti* and *ena bue emitsineti* (retained water in a river).

In Mosetén, several spots in water courses are identified based on water flow. The expressions *chɨk khan* (backed up water) and *chɨkɨjkɨs* (backed up water, pool in a river) refer to areas within a river where the water seemed to stand still, expressing similar concepts as the Takana terms *ebarereneti* and *ena bue emitsineti*, and the local Spanish term *remanso* (area of standing water in a river). Mosetén lexicalised the area in a lake or pond fed by water from a river or stream as *shɨpki'ya miedye' tsikes*, the area of the river that is fed by water from a lake as *chɨpkiya' miedye' tsikes*, and the lower end of an island in a river in the direction of the water flow as *wichɨ'e-tutyki'we pocho'*, which Mosetén consultants considered as a good fishing spot. There were no lexicalised expressions for these three concepts in Spanish or Takana.

In Takana, partonomy was lexicalised with body metaphors. For example, the expression *ena ai ebai* (riverarm) consists of the terms *ena ai* (river) and *ebai* (arm), the expression *enai ai kuatsa* (rivermouth) contains the term *kuatsa* (mouth). Similar metaphorical expressions of partonomy are found in Spanish (and English) with *boca del río* for rivermouth (containing the term *boca*, mouth) and *brazo del río* for riverarm (and the term *brazo*, arm). In Mosetén, no such body metaphors were documented, and the expressions for parts of watercourses were lexically not transparent (e.g. *shɨpbanwej* for rivermouth and *shirijo we'ñis* for riverarm).

The decision to include terms such as riverbank in this section on water terms rather than in the section on topographic terms was based on indigenous consultants who considered streambeds and riverbeds as elements of the water course.

Tab. 12 Folk hydrological categories in Takana and Mosetén

Indigenous terms	Approximate English equivalent
Takana terms	
bai	lake
bai pacha	oxbow lake, body of standing water in the forest
bai pacha judhe	area with oxbow lakes
ebarereneti	area of still standing water in the river
ebarereneti twathuthu	whirl in the river
ebuteji	pier, landing (referring to Rurrenabaque)
edja pupu	island in the water or in the pampa
ena ai	river
ena ai ebai	river arm
ena ai enakuatsa	rivermouth

ena ai epas'ereti jubidha	river that makes a lot of noise (with a lot of stones)
ena ai eturiaji	turn in the river
ena ai jubidha	river with a strong current
ena ai maje	riverbank of a larger river
ena ai s'a ekita	main channel of a river
ena ai tiputetipute epus'a	river with a lot of water
ena ai waichidhi	stream
ena ai wibu	peninsula in a river
ena baki	stream
ena baki as'e taji mawe	stream with little water (not navigable by canoe)
ena baki as'e taji	stream with a lot of water (navigable by canoe)
ena baki chidhi	small stream
ena biakuawa	upriver
ena bue	pool, lake
ena bue emitsineti	still standing, retained water in a river
ena bue chidhi	small pool
ena d'aba	shallow stream (with less current)
ena dhuedha	deep stream
ena ekuarareneti	area of upwelling water in the river
ena emakuawa	downriver

ena emuritani tumu ruruji	rapids, river that flows over stones
ena kuarekuare	reflexion of light in the water, crystalline water
ena kuatsa	mouth of a stream
ena maje	streambank
ena ni keke	streambank
ena rujuruju	area of blubbering water
ena wuad'a	oxbow lake, body of standing water in the forest
jutujutuji	beach, sandy
terijiji ena	pond
watsa	small lake in the pampa
wape	driftwood
yawi puti puti	well
yawui budju	waterfall
Mosetén terms	
an'dyei'	pool in a river, deep area in the river
bun'ku'	pool
chhetti'	river confluence, trail crossing
chhirijris	waterfall, falling water
chhorojros	waterfall, falling water
chi'	shallow place in the river
chɨk khan	area of still standing water, backed up water

chɨkɨjkɨs	area of still standing water in a river, backed up water in a river, pool in a river
chɨpkiya' miedye' tsikes	area of the river that is fed by water from a lake
chɨrsi'	waterfall
curkhan	streambed, canyon
fersi'	river current
jijmo'mo	well
jinak	stream
jinak ichɨkis	small stream
koiyiwa'tidye'	whirl in the river
majdye'khan	pool, deep area in a river (Covendo dialect)
mi'ëdyë'	stream
ojñi' dursi'	river
pocho'	island
ribij	whirl in the river
shewekya'	sidearm of a stream, river with low water level so that the river can be crossed on foot
shɨpbanwej	river mouth
shɨpki'ya miedye' tsikes	area of a lake that is fed by a stream
shirijo we'ñis	river arm
sinwe	riverbank, streambank
soyojyoy'	current where the river is deep

sukwen'yi'	whirl in the river, water flowing in circle
täjshä'	beach
tsike'	lake, standing water in the forest, oxbow lake
tsikë'	oxbow lake
tsïkëdyei'	area with oxbow lakes
tsïkïmwe	riverbank, streambank
tsodye'	port
tursi' täjshä'	large beach
wachha'manij	waves indicating rise of the water level in the river
wai'ñedye'	area of upwelling water
wichɨ'e-tutyki'we pocho'	lower end of an island in the direction of flow
wɨk	rapids
wïkya'	strong current when water flows out of a pool
wokwe	riverbank
yosko'	pile of driftwood floating down the river

Key messages Folk hydrological categories in Takana and Mosetén

- Both languages lexically distinguish particular elements of water courses such as different currents, and water levels, and areas in rivers where whirls develop
- In Takana, different sizes of water courses are distinguished, as well as different flow intensities.
- In Takana, body metaphors are applied to the waterscape to express partonomy.
- In Mosetén, places along the stream network were identified that were considered good fishing spots.

7.5 Some folk topographic categories in Takana and Mosetén

Takana topographic categories consist of 25 different categories that distinguish landforms based on different aspects such as size, shape and land cover (Tab. 13). Both convex and concave landforms were identified, but terms for convex landforms were lexically more differentiated. *Emata* was the Takana term for a large convex landfom, which would correspond to the term 'mountain' or 'large hill' in English (and *cerro* in Spanish). Smaller in size than *emata, muruku* was the Takana term for a convex landform characterised by a conical shape. Earth mounds or stone heaps of conical shape were referred to as *muruku chidhi* (small hill). In Takana, land cover was an important criterion to distinguish between rocky, bare mountains and mountains covered in vegetation.

To express the concept of a mountain ridge, in Takana, the term *ematakuana ewerereneti* is used, which contains the verb *werere* (to be in line). In Takana, as with waterbodies, body metaphors are applied to convex landforms. For example, the term *emata* (mountain, large hill) from the example above also refers to a person's forehead. The term for mountain top in Takana *ematina* is the short form of *emata matina*, which literally translates as the 'crest of a mountain'. The term *emata ebu* contains the term *ebu* (face), and the term *emata bedjedje* (mountain ridge) contains

the Takana term *bedjedje* (vertebrae). In Takana, mountains are thus conceptualised according to the template of body methaphors. The Takana consultant Leonardo Marupa stated that these metaphors were used by Takana speakers who had no knowledge of Spanish, and he therefore assumed that these body metaphors had been used in Takana before the arrival of the Spanish *conquistadores* and missionaries.

As the dwelling places of Takana deities, mountains are considered sacred places in Takana culture. Individual mountains are often referred to by toponyms. For example, the *Cerro Macuti* in the Madidi area was named after the spirit *Macuti*, master of the Southern wind in the Takana system of deities (Lehm Ardaya 2010).

In Mosetén, 31 topographic categories were elicited (Tab. 13). In Mosetén, the distinction between different landforms is based on size. The term for the largest convex landform is *mɨkɨ'* (mountain, hill). Smaller convex landforms include *rokchhe'* (hill) and *roktyi'* (small hill), as well as *dɨ'ris* (hill) *diri'* (heap of stones, sand or earth). Some parts of landforms are named, such as *mɨkɨ' durtyi'* (mountain top), which contains the adverb *durtyi'* (far away). This is probably because the common vista of mountains is from the lowland at the base of mountains or hills looking to the top. From such a distance a mountaintop or hilltop would seem 'far away' for Mosetén speakers. The term for slope or descent is *chhädyei'*, is derived from the verb *jö'chhaja'* (to fall), which is combined with the nominaliser *–dyei'*. In Mosetén, the slope is thus literally 'the place for falling'.

Tab. 13 Folk topographic categories in Takana and Mosetén

Indigenous terms	Approximate English equivalent
Takana terms	
cuadhata dume	gully

ebuteji	descent, slope
emata	mountain, hill, also forehead
emata bedjedje	ridge (lit. the vertebrae of the mountain)
emata ebu	slope, hillside, mountainside (lit. the face of the hill or mountain)
emata ejije	mountain or hill covered with forest
emata kuadhata dhume	ravine, gully, canyon
emata kuadja kuadja	ridge of a mountain or hill
ematakuana ewerereneti	mountain range, hill range (lit. the mountains are in line from the verb *werere* to be in line)
ematina	mountaintop, hilltop (short form of *emata matina* now commonly used, lit. crest of the mountain)
es'ipena	lowland
jaurua utetia	slope with lots of land slides
jauruati	landslide, mudslide
jawa pamapa	plain
jawajati	landslide, mudslide
kuadjata	embankment
muruku	hillock, knoll of conical shape (in the shape of a mountain)
muruku chidi	a heap or pile of earth or stones in conical shape (in the shape of a mountain)

rara	cave, cavity in the ground
riji mawe rara	cave so deep you cannot see the bottom
tumu aidha	cliff, rock
tumu djerena	coloured rock, cliff
tumu tserudha	bare cliff, bare rock
yatsi	plain, grassland, pampa
yawa pamapa	height, highland, flat land, plain
yawa pamapa	height, highland, flat land, plain
Mosetén terms	
bojwedye'	ascent, slope (*bojwi*, to ascend)
chhädyei'	descent, slope (*chhäi*, to descend, come down from high ground)
dɨ'ris	hill
diri'	heap of sand, stones, earth (also of fruit)
dyïchïn	hole, depression in the ground (Covendo dialect)
jijpadyei'	flat land, plain, pampa
jujwuj jujwes	mountain ridge
jujwus	gully
kayaj	cliff, rock
kayaj tɨshñety	bare cliff, bare rock
kayaj tyɨ'ñɨty	coloured rock, cliff

kur'khan	canyon, gully, ravine, narrow place in a stream enclosed by rock walls
mayei'khan	lowland
mɨkɨ'	mountain, hill
mɨkɨ' durtyi'	mountain top
mɨkɨ'ya'	mountain range
mɨkɨchhe'	height, on a mountain
mochhe'	a place high up (from adverb *moch*, 'far away')
mochkhan	pan, depression in the ground
nukujkhan	flat land, plain
rokchhe'	hill, small mountain
roktyi'	small hill
siminche	ridge
sinwe	lowland
tsikëdyei'	lowland
tsɨp	cave with closed entrance, closed animal cave
tsuɨ'	embankment
tyo'	depression, cavity in the ground, cave
wai'jodyei'	landslide
wokwe	slope, hillside
yashinkan	lowland

Key messages Folk topographic categories in Takana and Mosetén

- In Mosetén and Takana, both convex and concave landforms are identified, but terms for convex landforms are lexically more differentiated.
- Takana topographic terms distinguish landforms based on different aspects such as size, shape, and land cover
- In Mosetén, landforms are mostly differentiated based on size
- In Mosetén, landform terms contain verbs and adverbs such as the adverb *durtyi'* (far away) in the term *mɨkɨ' durtyi'* for mountain top and the verb *jö'chhaja'* in the term for slope *chhädyei* (lit. 'place for falling').

7.6 Some folk substrate categories in Takana and Mosetén

Takana people identified a range of substrates with different properties (colour, texture, edaphic regime) and uses with 13 folk substrate categories (Tab. 14). Sandy soils (*jutujutuji*) and black soils (*med'i d'erereta d'abid'a*) were considered good for planting peanuts, beans, water melon, onions, yucca and pumpkin. Clay soils (*med'i tudji judhe*) were suitable for plantains and bananas. Rice and maize were planted in soils rich in chalk (*med'i d'ewe*) and *d'arata* was the term for soil too wet for sowing any crop.

In Mosetén, 21 folk substrate categories were elicited that distinguished soils primarily based on their colour, but also on the edaphic regime. For example, the expression *tyïynïs jäk* and *jïch benkhansi'* refer to coloured (typically reddish) soils, *kao'dyei'* to soil the colour of coffee, and *mötsoredyei'* to blackish soil. An area consisting of dry soil was referred to as *chañeskhan*. Areas where the ground was rich in minerals and where animals came to abrade the soil, creating caves or large depressions in the ground were lexicalised both in Takana (*rai*), Mosetén (*sich*) and the local Spanish dialect (*salitral*). Areas where animals such as white-lipped peccaries came to wallow, creating a sort of 'mud bath' were expressed as *rai* or *wabu kuana s'a nawi judhe* in Takana, as *po'ñedyei'* in Mosetén, and as *bañero de chanchos* or *barrero* in Spanish.

Tab. 14 Folk substrate categories in Takana and Mosetén	
Indigenous terms	Approximate English equivalent
Takana terms	
d'arata	wet soil where nothing can be sown
ebaki ichaji	area with animal tracks
es'ipena judhe	area of mud
juchu juchu	area of mud
jutujutui	beach, sandy area, sandy soil
med'i d'erereta d'abid'a	black soils with slightly reddish colour
med'i d'ewe	chalky soil
med'i tudji judhe	area of clay, soil rich in clay
rai	mineral salt lick, mud bath for animals
rutu judhe	area of mud
ts'ipa djanata	ondulated terrain
tumu judhe	area of stones
wabu kuana s'a nawi judhe	lit. area where white-lipped peccaries bath
Mosetén terms	
bɨ'chas	area of mud
bojkadyei'	area of mud (from the river)
chhañeskhan	dry area
dyɨdyeskhan mɨmɨjñi	lit. area where white-lipped peccaries bathe
jäk yukus	hard clay soil
jamandyei'	beach, area of sand
jïch benkhansi'	coloured soil
jiñikyi'	area of mud
jɨñɨkyiskhan	area of mud
jujwiñjoy'	ground with a lot of depression or holes
käwäkdyes yɨj	area with animal tracks
kao'dyei'	soil with the colour of coffee
kayadyei'	area of rocks
mijdyei'	area of stones
mötsoredyei'	blackish soil
pirijwe	area of mud
po'ñedyei'	mud bath for animals
shejway'	area of gravel, gravelly soil
sich	mineral salt lick
tajsha'che' jamanche'	beach
tyïynïs jäk	coloured soil

Key messages Folk substrate categories in Takana and Mosetén

- Takana and Mosetén people identify a range of different soils with different properties and uses
- Areas where the ground was rich in minerals used by animals as mineral salt licks are lexicalised both in Takana (*rai*) and Mosetén (*sich*).

[…] there is a knowledge of place which is reducible to a sort of co-existence with that place, and which is not simply nothing, even though it cannot be conveyed by a description […].

Maurice Merleau-Ponty,
Phenomenoloy of Perception, 1962: p. 105

Chapter 8
From Space to Place: Representing folk landscape categories on maps and in a computational environment

This chapter deals with RQ4: *How can local understandings of landscape be represented on maps and in a computational environment?* By using sketch mapping (§8.1), I explored what features people choose to represent when asked to draw their surroundings, which I then compare with the results from the more ethnographic elicitation methods (Chapter 5). The combination of results from the ethnographic elicitation and sketch mapping provided the conceptual basis for representations in a computational environment presented in §8.2.

8.1. Sketch mapping

In the following, I present the results for RQ4.1: *What geographic features do people draw on sketch maps and how do they represent them?*

8.1.1. Geographic features represented on sketch maps

Consultants drew on average 6.83 generic features on their maps (± 3.36, n = 29 consultants), the highest number of features was 15 (n = 1 consultant) and the lowest number was 3 (n = 3 consultants). In all sketch maps, a total of 74 different generic landscape categories were represented (Tab. 15). Examples of features drawn on sketch maps are illustrated in Figure 29. The most

frequent features 10 or more consultants drew were *casa* (house), *río* (river), *arroyo* (stream), and *carretera* (road). Between two to ten consultants drew the same 27 features, including *camino* (path), *sendero* (path, trail) and *jatatal* (area of *jatata* palms). The more frequently drawn map features thus differed from the elicited folk landscape categories, as consultants only represented 23 folk categories on sketch maps (marked in bold in Tab. 15), compared with 156 categories that had been elicited through interviews and field walks. The frequency distribution showed a long tail, with 43 features that only once consultant drew. Among these features were some folk landscape categories (e.g. *bajío, barrero, riachuelo, isla, majal*), but also features such as people, animals (fish, cow, pig, duck), individual trees (often palm trees of different species such as *majo, asaí, motacú,* as well as timber trees such as *gabu, cedro* and fruit trees such as mango and orange trees).

Fig. 29 Snippets of sketch maps with different features

Fig. 29a

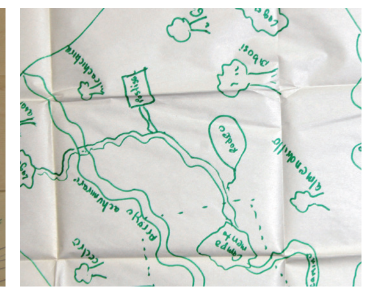

Fig. 29b

Consultants did not draw all the information they deemed relevant, and described some information orally during the mapping process. Eight consultants drew certain features on the map (such as river and walking paths in the forest), but explained others during the experiment, such as the location of a *jatatal*. The oral descriptions given for maps is in accordance with how indigenous peoples in the study area use sketch maps they draw with sticks into sand or clay, which then serve as the 'grounding' for an account of a hunting trip or to explain to someone where to locate a certain resource.

Tab. 15 Features drawn on sketch maps (folk landscape categories elicited also through ethnographic methods are represented in bold)

Spanish feature name	Approximate English translation	n
casa	house	19
río	river	19
arroyo	stream	16
carretera	road	11
camino	path	8
jatatal	area of *jatata* palms	8
sendero	trail, path	8
cerro	hill	6
chaco	agricultural field	5
comunidad	community	5
barbecho	fallow plot	4
cancha	soccer field	4
lago	lake	4
almendrillo	almendrillo tree	3
arboles	trees	3
canopy zip line	canopy zip line	3
puente	bridge	3
yucal	yucca field	3
bibosi	fig tree	2
campamento	camp site	2
chiquero	pigpen	2
curichal	area of oxbow lakes	2
escuela	school	2
marfíl	ivory-nut palm	2
pastizal	pasture	2
personas	people	2
piedra tallada	carved stone	2
platanal	plantain plantation	2
puerto	port	2
salitral	salt lick	2
serranía	mountain range	2
arbol de coco	coconut tree	1
arbol de soliman	soliman tree	1
área de cultivos	farming area	1
área de plantas medicinales	medicinal plant area	1
área forestal	area for timber extraction	1
asaí	asaí palm tree	1
bajío	lowland	1
barrero	area of mud	1
cabaña	hut	1
cachichira	cachichira tree	1

calle	street	1
cascada	waterfall	1
cedro	cedar tree	1
cerdo	pig	1
chancho	pig	1
chaquillal	stand of *chaquillo* trees	1
colina	hill	1
refugio	shelter	1
gabu	*gabu* tree	1
isla	island	1
laguna	lagoon	1
límites de comunidades	borders of communities	1
maiz	maize	1
majal	majo palm	1
mango	mango tree	1
motacú	motacú palm	1
nacientes de agua	watersheds	1
naranja	orange	1
parabal	nesting area of macaws	1
pato	duck	1
peces	fish	1
plantas	plants	1
platanos	plantains	1
poblaciones grandes	large settlements	1

pueblo	town, village	1
riachuelo	stream	1
tanque de agua	water tank	1
toronja	grapefruit	1
troncos de arboles	tree trunks	1
vaca	cow	1
villa	village, small town	1
zona de cultivos	farming area	1
zonas de casería	hunting area	1

Key messages Geographic features represented on sketch maps

- Consultants drew on average 6 generic features on their maps. The most frequent features drawn by more than ten consultants were house, river, stream, and road.
- Consultants drew less categories on maps than were elicited through fieldwalks and interviews.

8.1.2. Perspective and scale on sketch maps

For the perspective on their maps, twelve consultants chose an aerial view with a high vantage point and a perpendicular view to the Earth’s surface (similar to the perspective in an orthophoto), eight chose a sideways perspective for a pictorial map and nine used a blend of the two, where some features where represented from aerial view and some from a sideways view. Within the maps that combined aerial views and pictorial representations two types can be distinguished: one type of maps showed the home/village at the centre of the map in a sideways perspective and the surroundings in aerial view, such as the agricultural fields and trails, while the other type of maps showed the village in aerial view and the surroundings in a sideways perspective, often with a viewpoint from the river facing the mountain range in the background (e.g. Fig. 30a). The direction of the sideways perspective was often the same that consultants had in the environment while they were drawing the map. For example, people drawing the map while facing the mountain range often chose this view direction (if they chose a sideways perspective at all). However, I could not verify whether they chose to map this view direction because of the position in space they had chosen for possibly other reasons (comfortable seat, direction of sunlight), or, whether they positioned themselves in order to have this view while drawing the map. Scale often reflected the importance of a certain place, rather than geographic scale. Important things were drawn at larger scales and taking up more of the map space, and often at the centre of the sketch map, while consultants drew elements they considered unimportant at smaller scales.

Apart from the perspective, the level of abstraction consultants chose varied considerably. Some consultants drew a pictorial representation of the environment, using low levels of abstractions. Other consultants represented their surroundings as an abstract network, representing trail crossings as nodes and the trails as edges in the network (Fig. 30b).

Fig. 30 Examples of sketch maps with different perspective and levels of abstraction

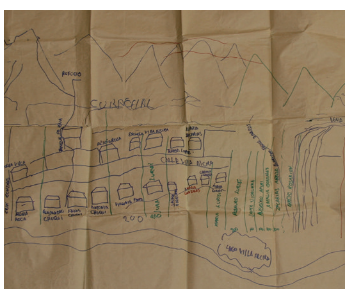

Fig. 30a

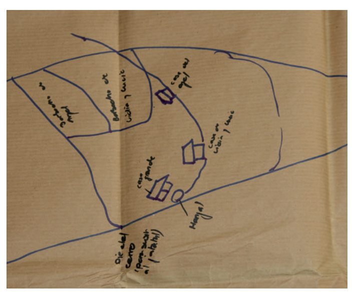

Fig. 30b

Two consultants drew the network from an aerial perspective and included no other features on the map, indicating specific locations with toponyms orally while explaining the map. Interestingly, these two consultants were male and experienced hunters who had no or very little formal schooling, which minimises the possibility that these consultants had been exposed to standard cartographic maps before. Given the low sample size it is impossible to draw conclusions on the influence of gender or education on the way people represent their surroundings on a map, but there might be no direct relationship between the level of education and level of abstraction chosen for mapping.

The sketch mapping exercises highlighted that there are a variety of ways people chose to abstract their surroundings to represent them on a map. Given this variety, there may be no 'best' or only one way of representation, suggesting that multiple representations at different scales, with users being able to switch between them, may be a better solution than trying to chose one way of representation.

Key messages Perspective and scale on sketch maps

- Different consultants chose different perspectives for their sketch maps, consisting either of aerial views, perspective views, and some blended both perspectives
- The level of abstraction consultants chose varied considerably, some drew a pictorial map while others represented trail crossings as nodes and the trails as edges in the network using high levels of abstraction
- There seemed to be no direct relation between the level of abstraction and education

8.2. Representing place-based local knowledge in a computational environment

This paragraph deals with RQ4.2: *How can local understandings of landscape be represented on maps and in a computational environment?* I first introduce how two institutions in the study area, the Madidi protected area, and the Takana indigenous territory currently use GIS for management. The Madidi protected area serves as an example of a governmental organisation using GIS, and the Takana council CIPTA is an example for an indigenous group applying GIS. Based on the constraints identified in the current use of GIS for these two institutions, and the local knowledge documented during the ethnographic fieldwork and sketch mapping exercises, I present suggestions of how both the spatial data (space) and other content (aspects of place that speak more to the local knowledge about culturally identified landscape types) can be handled in a computational environment.

8.2.1. Use of GIS and mapping in the Madidi protected area

In the Madidi protected area, GIS was introduced as part of the general set-up of protected areas in Bolivia administered by SERNAP. Trainings in collecting data with handheld GPS devices and handling GIS were part of the staff capacity building programme financed by international NGOs such as the World Conservation Society (WCS). The software used at the SERNAP office is ESRI ArcGIS. GIS was predominantly being used for visualising geographic information such as administrative boundaries, rivers, soil types, settlements, topography, and management zones on maps for reports and management plans (Fig. 31).

Protected area staff collected spatial data through the use of handheld GPS, for instance, on transect walks to assess biodiversity or on monitoring visits to check for incidences of rule violations such as commercial logging inside the protected area. Spatial information was then transferred to and stored in one of the two desktop computers with ArcGIS installed at the local SERNAP office in San Buenaventura. For transferring data between different institutions, ArcGIS shapefiles were used, and sent, for example, to the SERNAP main office in La Paz as a zip-file. In this process, often not all files are correctly copied, which leads to problems in transferring geographic information within the same

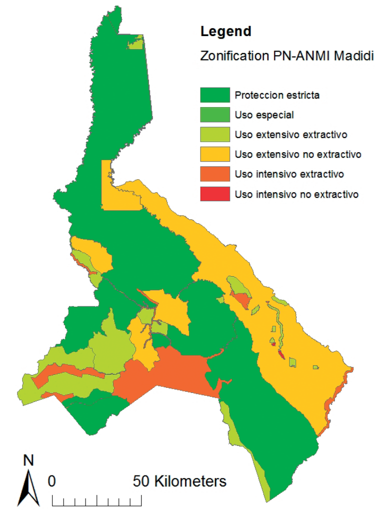

Fig. 31 Example of a zoning map in ArcGIS used for the management of the Madidi protected area (own illustration, data courtesy of SERNAP)

institution, as well as between different institutions. Interviews with SERNAP staff members reveiled some issues with the use of ArcGIS. Many staff members based in the field as park guards had little or no computational training and complained about the difficulty of operating ArcGIS. They found uploading data from their GPS after a field trip into ArcGIS was cumbersome, involved a lot of steps or clicks and often failed (e.g. ArcGIS showing error message when they tried uploading a text file containing coordinates). The more proficient GIS users were staff members who had completed university degrees in environmental studies or biology in larger Bolivian cities such as La Paz and Santa Cruz, where GIS had been part of the curriculum of their studies. During my field work two female staff members were employed as environmental technicians to handle GIS data, but both of them felt they still needed more training in GIS.

One of the most common uses of GIS in the Madidi protected area is for natural resource management. People living inside the protected area have to submit management plans for resource extraction (e.g. timber), or for creating a new agricultural plot. They submit a proposal that contains the coordinates where the planned activity will take place. At the SERNAP office, this so-called *solicitud* is then checked by plotting the coordinates of the planned extraction onto the management zones in ArcGIS (Fig. 31). If an extraction plan details the wood extraction is to be carried out in a 'strict conservation' zone, the *solicitud* will be denied. However, apart from the borders of the different protection zones, the staff members have very little geographic information available. For instance, the planned extraction might take place near a small stream and risk contaminating important water sources for communities, but this information is not contained in the GIS and not available for decision-making. Similarly, local uses of the land are not documented. For instance, the location of *barbechos* (culturally recognised fallow plots) were never mapped and thus may have been included in strict conservation zones. Thus, if people nowadays submit a proposal for agricultural production within such a zone, their proposal will be denied, even if they proposed to re-use an existing *barbecho*.
During the participatory observations, gender-differences in the use of GIS came to the fore. While the predominantly male park guards complained about the difficulty of 'getting their head around' ArcGIS, arguing that they are based in the field and therefore not trained to handle computers, the female staff members based in the office had received training and were more proficient and confident in using GIS. In the neighbouring protected area of Pilón Lajas, the only member of the staff who was confident in using GIS for the common tasks was a female park guard (1 of the 2 female park guards out of more than 10 park guards) to whom all other park guards turned for help. In both protected areas, the male park guards seemed to pride

themselves more on their outdoor skills when working in the field, constructing GIS technology as an indoor-technology related to office work, which is seen as something where women typically excel more.

8.2.2 Use of GIS in the Takana indigenous territory

In 2013, the Takana indigenous council CIPTA had one desktop computer at their offices in Tumupasha, for which they had obtained a license for ArcGIS through their collaboration with the Wildlife Conservation Society (WCS). At that time, WCS was also funding a topographer to manage spatial information (i.e. administrative boundaries) and provide GIS support for CIPTA. According to this topographer no other person at CIPTA ever used GIS. The council members stated that nobody else used the GIS because it was 'too complicated'. Issues that council members mentioned were that there were 'too many buttons to click' in ArcGIS, and that uploading files was not intuitive. Guillermo, a council member said:

I don't touch that computer [with the GIS installed]*. The GIS is too complicated, there are so many buttons, I can never remember which ones to click. I get confused. And I'm afraid if I click something wrong I can ruin the whole thing.*

In 2014, the ArcGIS license had expired and there were no funds from WCS available for funding a topographer. At that time, a new person had been hired who had practical experience with using GIS. The most pressing issue in 2014 and 2015 was for CIPTA to produce maps for the territorial management of communities within the TCO Takana, such as zoning plans for individual villages. At CIPTA, the GIS was thus mainly used for the management of the TCO Takana. As an indigenous organisation, one of the goals of CIPTA is to maintain Takana knowledge, practices and customs. Ethnographic fieldwork has shown that a considerable part of this knowledge of Takana people relate to landscape and landscape units. However, this knowledge is currently not documented, and not even the GIS managed by CIPTA contained information on the cultural uses of the land by Takana people. Currently, the maps used in ongoing negotiations about territorial claims with the Bolivian government and campesino organisations therefore do not contain any culturally-specific information on Takana culture and use of their territories, but rely on representations of purely administrative geographic information. The Takana council therefore expressed interest in solution that made it easier to handle geographic information, and to add cultural information that related to the land.

8.2.3 Requirements for a GIS

Although the needs for a geographic information system differed slightly between the organisations responsible for managing the protected area and the indigenous territory, in Table 16, I identified some common challenges and the respective requirements that a GIS would have to fulfill to be more suited for the use by SERNAP and CIPTA staff members, and potentially also for the broader public, such as CIPTA community members.

Tab. 16 Current challenges and identified requirements for a GIS

Current challenges	Identified requirements
Licenses (difficulty to get and renew)	Open-source software
ArcGIS is too complicated, consultants find easy tasks difficult	Simple user-interface with easy interaction for simple tasks
Use only very few functions, but difficult to locate these because of a lot of possibilities to 'do wrong'	Reduced functionality compared to ArcGIS
Difficult to share information with other staff members and other organisations	Online platform where users can share geographic information
Cannot easily upload pictures and textual information	Able to easily handle qualitative information
Access restriction is based on who has access to desktop computers. But if files are transferred on USB sticks, anybody could gain access	Possibility to identify different groups of users with different rights to view and/or edit data, e.g. for culturally sensitive data

8.2.4. Cartaro evaluation

Based on the requirements identified, I chose the Cartaro web-mapping platform and content management system as a suitable solution for the needs of organisations and individuals in the study site. The set-up of the platform is described in the Methods section. The Cartaro platform adapted for user-requirements and used in this study is shown in Figure 32. Here, I focus on how consultants reacted to the Cartaro webplatform in the workshops, and according to workshop participants, what challenges still remain to be addressed.

Consultants all liked that the Cartaro platform was free to use and no license was required to be renewed. Most found it much easier to use, although it was in English, as most ArcGIS software was in English as well and they were used to not understand the instructions on the labels, but to remember 'where to click' for certain tasks. Consultants thought that the functionality of pointing on a map with the mouse and creating a point was a good feature that would make their work much easier. Because Cartaro enables the use of both GoogleMaps and OpenStreetMap, consultants were able to switch between different base maps, which they had never done before in ArcGIS (despite the possibility ESRI basemaps offered, but consultants had not been aware of this option). Consultants liked that they could upload descriptions and pictures of locations, and that, compared to Google-Earth, these pictures were stored locally and they did not have to upload them to the web beforehand, which was not possible for these organisations.

When asked what content they would upload to the Cartaro platform, most statements from indigenous consultants included geographic information such as rivers, locations of villages and administrative boundaries. Despite the workshop content of mapping local knowledge, and the emphasis on the importance of features such as *jatatales* (*jatata* palm harvesting areas), *barbechos* (fallow fields with traditional use rights) or *salitrales* (sacred mineral salt licks) during field walks and interviews, only few consultants stated they would map such areas. The function that different users could upload and edit data was very much appreciated, and, using the possibility of creating different user profiles with associated rights to view, add, or edit data enables a more nuanced management of culturally sensitive information than all rights (handing over shapefiles) or no rights (not being able to view information).

The biggest challenge identified with the Cartaro platform was that although the server was installed locally on laptops, the Cartaro platform needed internet to download the information for the basemaps. However, the map information could also be cached and stored locally.

One of the constraints SERNAP staff identified was that although a platform such as Cartaro would be useful, the requirements from SERNAP head office in La Paz and other governmental organisations required geographic information to be delivered as shapefiles, which consultants interpreted as that the use of ArcGIS was mandatory. For consultants of indigenous organisations

this was less seen as an issue, as they saw potential in using the platform for documenting their use of space and local knowledge about places as an important part of territorial claims and negotiations about land management.

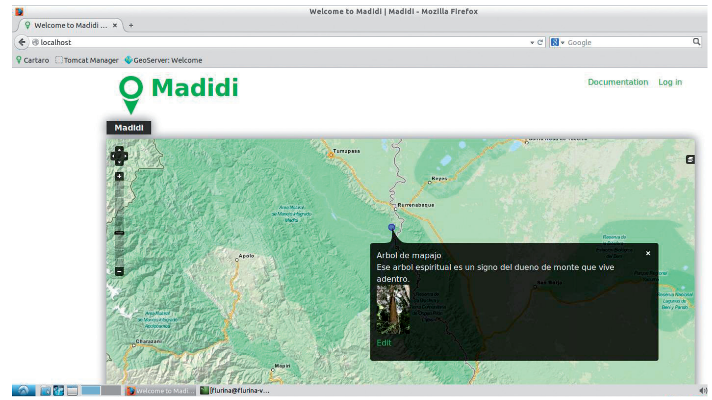

Fig. 32 Cartaro user-interface with an example of user-generated content

Key messages Representing local knowledge in a computational environment

- In both the protected area and the indigenous territory staff members used GIS for decision-making, but stated they faced challenges dealing with GIS
- Based on the identified challenges and requirements I chose the open-source Content Management System of the Cartaro webmapping platform
- In evaluation workshops, most consultants rated the Cartaro platform easier to use than the GIS, and appreciated the added functionality of including pictures and texts with the geometric data, but some usability issues remain

A thinker sees his own actions as experiments and questions - as attempts to find out something. Success and failure are for him answers above all.

Friedrich Nietzsche, in:
The Gay Science, 1882

Chapter 9
Discussion

The introduction to this thesis raised questions including, do all people, irrespective of their culture, language and background perceive their environment in the same way, or are there differences in how people carve up their surroundings into identifiable, shared categories (Mark, Turk, and Stea 2007)? The preceding chapters described research exploring how perceptions of landscapes are expressed in language through the use of landscape categories, and how these categories and their associated semantics vary between people speaking different languages, as well as between groups of people speaking the same language, but who are situated in different institutional frameworks. In the following, I will both discuss the main findings of this thesis with respect to the research questions and highlight how the empirical results of a case study in Bolivia can contribute to broader theoretical questions and research in fields such as, for instance, GIScience and landscape ethnoecology.

9.1 Institutional pluralism and struggling ontological communities

· *RQ1: What is the current institutional setting for natural resource management?*

Empirical research on the history and institutional setting in the study area brought to the fore that different institutions for natural resource management co-existed in the same geographical area. In this situation of institutional pluralism (Benda-Beckmann 1981; Haller and Merten 2008), different user groups referred to that institution which, in a given situation, provided legitimacy for their claims on natural resources. Such situations are common for protected areas, where different groups hold different views of people-nature interactions and apply these to their respective management practices.

In the Madidi area, from the perspective of Takana indigenous people, the rainforest is essentially a cultural landscape used and modified by people, which is congruent with other reports from indigenous groups in the Amazon (Balée 2013; Gilmore, Ríos Ochoa, and Ríos Flores 2010; Descola 1996). Empirical research for this thesis further highlighted that for Takana indigenous people, the rainforest was a place imbued with meanings and memories. The Takana people's relations to the landscape thus go far beyond utilitarian considerations, but relate more to a ‘sense of place’ (c.f. Basso 1996; Cresswell 2006). In contrast, natural scientists, including biologists and ecologists, have portrayed rainforest landscapes such as the Madidi as a product of solely natural processes (Hoorn et al. 2010; Spector 2002). This view is based on an ideology of ‘pure nature’ and fosters arguments that rainforests need to be protected from (any) human use. Through the creation of the Madidi protected area, the different visions on the relationship between nature and society came together in the arena of resource management, resulting in tensions between management staff and indigenous peoples. Similar outcomes were reported for other protected areas in Latin America and elsewhere (Bottazzi 2008; Galvin and Haller 2008).

This case study in the Madidi revealed that conservation NGOs involved in the creation of the protected area implemented strict regulations for nature protection that were superimposed on the existing local belief and value system, resulting in conflict with people who legitimised their claims based on different institutional frameworks. Particular to the Madidi case was that staff members of the protected area enforced stricter restrictions on human use of resources than the formal protected area rules implicated.

The tensions observed in the Madidi protected area can be construed as 'struggles of ontological communities', where an ontological community is defined as a group with a common worldview, or, more specifically, as a group sharing a set of basic presuppositions about social and natural reality (Boillat et al. 2008). An important part of these basic presuppositions are how people abstract and structure reality, and the categories they use to express such abstractions through language. Categories are thus embedded into ontological communities that are linked with institutions and management. Importantly, although this thesis focused on exploring folk categories of landscape, the empirical research on institutions provided an important background for assessing the different 'ontological communities' in the study area and how they differed in their landscape categorisation. Furthermore, the attention to the institutional setting helped in remaining cognisant during research of the real-world implications of landscape categorisations in different institutional frameworks.

In the following, I discuss the main findings for the empirical research on folk landscape categorisations in Spanish (§9.2), their hierarchical organisation (§9.3), followed by Takana and Mosetén landscape categories (§9.4), and how such folk landscape categories can be represented to bridge the gap between space and place (§9.5)

9.2 Folk landscape categorisation in the Spanish Beniano dialect

- *RQ2: What categories are culturally recognised in a landscape folk categorisation and what are their ecological underpinnings and cultural significance?*

This research was based on work with over 10 consultants, who were selected based on theoretical sampling, thereby ensuring that consultants represented a broad sample from local communities (gender, age range, occupation, and living situation). In other related ethnophysiographic and landscape ecological work, typically less than 10 consultants contributed to the compiled landscape vocabularies (e.g. Mark, Turk, and Stea 2010; Johnson 2011), and most consultants were elderly people still fluent in an indigenous language, thereby representing only a small section of the local community. The sample size of this thesis is therefore comparable to previous work, but with a broader age range, and including both male and female consultants. As interviews with more consultants did not result in a considerable increase in landscape terms, I deemed that a saturation point had been reached. However, as the selection of consultants influenced which places were visited on field walks, and, as a consequence, which landscape pictures were included as prompts for interviews on landscape terms, selecting different people as consultants may have resulted in different sets of photographs as prompts, influencing what categories were elicited. By including photographs of new terms elicited during interviews with consultants who had not accompanied me on field walks, I extended the set of landscape photographs used as prompts to limit the potential bias of the selection of consultants for field walks.

Different consultants showed a high agreement on the terms they used to describe photographs. The documented folk landscape vocabulary therefore represents culturally shared categories used to describe landscape. As these terms were shared among members of the speech-community, this indicates the documented categories were not created *ad-hoc* for describing certain features of the landscape to the researcher, which was posited to be the case for some of categories elicited in previous work (Johnson 2010b). Although the elicited categories were shared within a speech-community, the presented compilation of landscape categories is not static. Landscape vocabularies are constantly changing, with new words being added and others forgotten (Macfarlane 2015), for example through acculturation processes. Furthermore, landscape terminologies may change within a generation, as illustrated in the inter-generational differences between folk hydrological categories used by Cree (Wellen and Sieber 2013). Thus, the landscape categories presented in this thesis are a snap-shot of current ways of referring to units of the landscape in the study area.

The etically defined group of vegetation was lexically most diversified in the Spanish folk landscape categorisation, followed by agricultural and water-related landscape categories. Folk landscape categories often referred to areas that were perceptually and/or ecologically distinct from surrounding areas. For instance, vegetation categories mainly referred to areas that were visually dominated by an indicator plant species, often of economic importance or associated with cultural meanings. While perceptual salience may play a role in the identification and parceling out of underlying referents, the meanings attached to these folk landscape categories were shared within a speech-community and closely linked to the specific socio-cultural context. For instance, *salitrales* (mineral salt licks) are important hunting spots and associated with different cultural norms. This finding is in line with previous landscape ethnoecological work, where the local uses and preoccupations influenced the landscape units identified (Johnson 2011; Aporta 2010; Johnson 2010b). Thus, affordance that are instantly perceived in a Gibsonian sense (Gibson 1977)

did not appear to be the main reason for which parts of the landscape are identified and lexicalised, but rather the culturally-shared uses and significance of these units in the local ethnoecology.

9.2.1 Folk landscape categories and category norm studies

Comparing the results from this thesis with empirical category norm studies on geographic features, there are considerable differences. For instance, the category *monte alto* (rainforest) was most frequently used to describe photographs by consultants in this study, but did not occur in any other category norm study on geographic features (Battig and Montague 1969; Mark, Smith, and Tversky 1999; Pires 2005; Williams, Kuhn, and Painho 2012). Furthermore, few consultants in this study used the category *montaña* (mountain), which is among the top five common labels in category studies on geographic features (Battig and Montague 1969; Mark, Smith, and Tversky 1999; Pires 2005; Williams, Kuhn, and Painho 2012). Reasons for these observed differences may be manifold.

Firstly, participants in category norm studies were usually university students with an urban lifestyle (Giannakopoulou et al. 2013; Mark, Smith, and Tversky 1999; Pires 2005), while consultants in this study interacted with landscape on a regular basis and were highly dependent on natural resources, which may have resulted in consultants having a more detailed vocabulary for landscape used in daily speech.

Secondly, category norm studies were most often conducted inside buildings, with the goal to exclude visual and other stimuli from influencing results. Respondents were therefore not able to see any landscapes while they were filling out the questionnaire. Exceptions are the study of Williams et al. (2012) that used videos of both familiar and unfamiliar landscapes as stimuli for the free elicitation task, thereby evoking people's memories of familiar landscapes not shown in the video. Another example is our study on Swiss landscape categories where we conducted free listing in outdoor environments, showing that the landscapes where the free listing exercises were conducted influenced the frequency and congnitive saliency of terms listed (Wartmann et al. 2015). Conducting free listing exercises of category norms inside buildings may result in participants applying different memory search strategies, resulting in lists for different landscapes (beaches, deserts, forests etc.). In this study, the field walks conducted as part of the ethnographic data collection protocol resulted in people naming generic terms for landscape types that were traversed, providing a more direct perspective on landscape categories in the study area.

Thirdly, differences may be caused by different methodological approaches. Although free listing is commonly applied in geographic category experiments with university students (Giannakopoulou et al. 2013; Mark, Smith, and Tversky 1999; Pires 2005), and was applied in cross-cultural ethnographic research on cognitive domains such as food and diseases, I deemed this method unfeasible in the cultural context of the study area. Instead, I applied ethnographic methods such as field walks and semi-structured interviews that were not only appropriate to answer the research questions, but that consultants deemed culturally acceptable. The results of this thesis are therefore not directly comparable to previous category norm studies, but may be used to suggest further avenues for research into (folk) geographic categorisation. Furthermore, it is important to note that through the loss of control in these field experiments in comparison with previous category norm studies, other biases may be introduced, for instance a preference for naming geographic features at the vista scale (Montello 1993), rather than geographic features at larger scales, such as mountain ranges.

9.2.2 Linguistic aspects of Spanish folk landscape categories

In the group of elicited Spanish folk vegetation terms, the majority of roots were loanwords from different languages such as Takana, Chané, Chiquitano, and Portuguese. Topographic terms, however, consisted entirely of standard Spanish terms, although a vocabulary for topographic features was available in the Takana language. I hypothesise that where lexical gaps occurred, such as for local plant species for which no Spanish names existed, Takana loanwords representing Takana concepts of landscape types were absorbed into Spanish vocabulary. Where Spanish terms were available, as was the case for topography, native Takana speakers adopted these. Takana speakers may have adopted Spanish terms because of the increasing influence of the state education system (CIPTA 2010), the interruption of intergenerational learning and a general stigmatisation of people speaking an indigenous language as being backward and uneducated (pers. comm. L. Cáceres). Vegetation and substrate terms were often lexically transparent, consisting of a root referring to an underlying referent such as a plant or soil type, combined with the Spanish suffix *–al*, meaning 'a place of'. The findings thus support the claim that generic folk landscape terms are often more than purely referential, as they may have 'descriptive force' (Hunn 1996), allowing speakers to make inferences about the properties of the underlying referent. As generic landscape terms are often contained in toponyms, this finding further supports the claim that toponyms may have encapsulated meanings and may be more than pure referential expressions (Coates 2006).

In order to compare the folk categories with a scientific classification, vegetation terms were the only thematic area where there was a published scientific categorisation for the study area available. Both the Spanish folk categorisation and the scientific botanical classification appear to rely on indicator species for identifying vegetation units. More folk vegetation categories were elicited in the Spanish dialect for the study area than were published in the botanical classification for the entire Madidi region (Fuentes 2005). The scientific classification thus identified vegetation units with larger spatial extents, while many folk vegetation categories referred to vegetation patches at finer granularities. However, the scientific classification is extendable by adding species names to indicate smaller patches within an overall vegetation type. Folk categorisations may therefore provide valuable information for developing more detailed formal botanical classification systems (Shepard, Yu, and Nelson 2004). Furthermore, ethnoecological classifications, for instance of indigenous groups of the Amazon have also been used as predictors of rainforest habitat diversity (Abraão et al. 2008; Shepard, Yu, and Nelson 2004).

Differences in the degree of diversification of a category system could simply be dismissed as effects of intensity of study. Thus, it could be argued that if scientists had more time to study these environments, they would also come up with more detailed classifications.

The results of this thesis also brought to light differences between folk and scientific categorisations at a more conceptual level. For example, Takana identify certain patches within a forest as previously used agricultural fields called *barbecho* (fallow field) in the local Spanish dialect. These patches were often labelled as 'primary rainforest' in the scientific classification, because of the difficulty of recognising these patches of fallow plots inside the rainforest. However, even if scientists identified the fallow plots as 'secondary rainforest' or *barbechos* in the local dialect, this would not resolve the issue revolving around this landscape category. The empirical data showed that although some folk landscape categories may be lexically identical to Standard Spanish, the associated concepts and meanings can differ. For the aforementioned category of *barbecho* (fallow field), indigenous people derive use rights based on family membership, whereas

for non-indigenous Spanish speakers, there are no use rights associated with a fallow field.

Research has shown that contestations over how certain areas can be used may arise despite the fact that different people refer to it with the same term, because different semantics are associated with the same term in different communities of practice, for example for the geography category of *forest* (Comber, Fisher, and Wadsworth 2005) or *wetland* (Harvey et al. 1999). In this thesis, by taking into account the institutional and social context from a political ecology perspective the implications of landscape categorisations were revealed. For example, in the terms of Robbins (2001), landscapes or their constituent parts are engineered through 'reverse adaptation' to fit the categories they have been assigned. In the Madidi area, one such example is the category of *primary rainforest*, where protected area management staff attempted to re-engineer this 'pure nature' by excluding indigenous peoples from using the forest for subsistence and cultural purposes.

9.3 Hierarchy and drivers of folk landscape categorisation

- *RQ3: How is a folk categorisation of landscape organised and what are drivers for landscape categorisation?*

In studies on hierarchies of (biological) folk categorisations, written labelled cards have often been used (López et al. 1997; Medin et al. 1997; Medin et al. 2006). However, because written labels were shown to influence the organisation based on lexical similarity, and not on the perceived similarity of the underlying referents (Medin et al. 2006), and because of variation in educational level of consultants, this study relied on sorting exercises of landscape photographs, which proved productive, and was well accepted by consultants. Thus, in cross-cultural context I would highly recommend the use of photographs of underlying referents instead of labelled cards, as the photographs appear more likely to trigger memories of the places or landscape types, leading to sorting of the photographs according to criteria for the underlying referents, rather than on lexical similarity of landscape terms or similarity of the photographs. Despite the apparent advantages of using photographs, there are also possible disadvantages, such as the potential interpretation as specific places or instances, rather than categories. However, this did not seem to be the case in this study, as consultants were presented photographs of mostly unknown locations.

In this study, consultants used few hierarchy levels in grouping landscape photographs. Most consultants made only two levels. This result is in accordance with previous work (Medin et al. 2006; Paz and Begossi 1996; López et al. 1997; Furbee 1989) demonstrating folk biological hierarchies to often be flatter than expected by theory (Berlin 1992). However, in the geographic domain, the study by Duvall (2008) on the hierarchical organisation of physical geographic features documented several hierarchical levels, some of which were unlabelled, covert categories. In this study, there was no indication of the existence of covert categories, because consultants labelled all groups of photographs.

For the different levels in folk categorisations, Berlin (1992) coined the term basic level and superordinate level, stating that in folk hierarchies, for coining basic vegetation terms, predominantly the plant genus (e.g. *birch*), rather than the species (e.g. *silver birch*) would be used. The terms consultants used to name groups of landscape photographs represented a different hierarchical level in the folk landscape categorisation than the terms for the members they contained. Following Berlin, most folk vegetation terms in the Spanish Beniano dialect, such as *jatatal* (are of *jatata* palms) would therefore have to be considered basic level categories, and the terms for groups of photographs, such as *monte alto* (rainforest), *orilla* (riverbank), *río* (rivers), and *chacos* (agricultural plots) would be candidates for superordinate categories. The categories at higher hierarchical levels typically referred to underlying referent areas with large spatial extents at the *environmental space* scale of perception, and the more basic levels to smaller areal extents at the *vista space* scale (Montello 1993), suggesting that scale may also play a role in the categorisation of folk landscape categories. However, what is cognitively 'basic' may differ between different speech communities (Tanaka and Taylor 1991). Although folk vegetation categories are good candidates for representing basic levels in the Takana speech-community, Spanish speakers from other geographic areas and with different backgrounds would perhaps consider these categories subordinate, and *monte alto* as a basic level. However, as I did not conduct experiments with consultants to determine the cognitive basic level, I can only hypothesise about which categories would be good candidates for which cognitive level, based on the collected ethnographic material.

9.3.1 Prototypicality and graded membership

When asked to point out typical members, consultants selected some photographs as more typical members of a category than others. In general, consultants showed a high agreement on typical members for a category, and often indicated less typical members, as well as 'intermediary' examples. This finding relates to the theory of graded membership in categorisation, which postulates that membership of natural language categories is not binary as in logical set theory, where a set of attributes determines inclusion or exclusion, but rather exhibits a more graded membership with some more and less typical members (Estes 1994; Berlin and Kay 1969; Rosch 1978; Smith and Mark 1998). The notion of typicality is based on the number of attributes a member has of a certain category. The results of this thesis suggest that just as a *finch* is a more typical example of the category *bird* than a *penguin*, a *jatatal* (stand of *jatata* palm trees) is a more typical member of the category *monte alto* (rainforest) than a *curichi* (oxbow lake). Such notions of membership however, are highly likely to be culturally dependant. Recent cross-cultural experiments on picture sorting exercises of geographic features that compared Navajo with English speakers showed that Navajo speakers selected a picture of a culturally important site as a typical example, which English speakers without local knowledge considered as an outlier and 'strange' picture (Klippel et al. 2015). The results suggest that the arrangement of landscape features (or their topology), must be considered as an attribute, because it often influenced which categories were considered typical and which not.

9.3.2 Categorisation drivers

Although in this study, all categories were named, some of them still constitute relatively 'loose groupings', for which the perceived similarities were investigated as potential drivers for categorisation. Most consultants mentioned more than one driver for categorisation, and no driver alone was able to explain the resulting organisation of categories. Therefore, I suggest multiple drivers interact in influencing folk landscape categorisation, which is in accordance with a previous study on landform categorisation that documented an interplay of different drivers (Williams, Kuhn, and Painho 2012). One of the investigated potential categorisation drivers was utility (Posey 1984). However, consultants did not mention utilitarian factors as reasons for grouping photographs together and did not group landscape elements with similar uses consistently together. Utility is therefore unlikely to be a covert driver for categorisation. Several consultants mentioned to have used the degree of human interaction to group photographs, thereby distinguishing forests from agricultural areas, as well as differentiating agricultural areas with different intensities of use, such as old fallow plots, new fallow plots and recently plowed agricultural plots. Semantic links, such as shared properties of different landscape units (e.g. water, vegetation) were

considered to be a potential categorisation driver, as these are commonly assumed to be an organisational principle, at least implicitly, by using them to structure the reported landscape categories (Johnson 2011; Krohmer 2010). However, these semantic links were not able to explain the resulting superordinate categories. For instance, some landscape units containing water were never grouped together, and neither were certain vegetation types. Thus, despite many ethnoecological studies reporting results using such etically defined categories as 'soil' and 'vegetation', these may not reflect how people conceptualise landscape categories. Similar to landscape categories, landscape hierarchisation may also differ cross-culturally and cross-linguistically. Therefore, studies on folk landscape categorisation should not only elicit the categories themselves, but also information on how people group these categories in the folk hierarchy.

In this study, consultants often grouped landscape elements together that had topological relations, such as containment (an oxbow lake found inside the rainforest) or adjacency (a certain vegetation stand found next to a river), and several consultants mentioned partonomic relationships between category levels as reasons for grouping certain photographs together. The results of this thesis therefore provide empirical evidence for theoretical postulates that an ontological theory of the geographic domain must both contain a partonomy (or mereology) and a topology (Smith 1996). The spatial arrangement of geographic features is by nature more stable and enduring than an arrangement of, for instance, furniture in a room, which may also influence how people categorise geographic features. This links to our study on memory search and retrieval of commonsense landscape categories, that found that terms in free listing tasks were often retrieved from memory for similar landscapes, suggesting that people used the arrangement of geographic features as an organisational principle during memory recall (Wartmann et al. 2015).

9.4 Folk landscape categories in Takana and Mosetén

· *RQ4: How does the categorisation of the same landscape differ between different groups of people?*

While I conducted a considerable number of field walks with Spanish-speaking consultants to document landscape terms, I relied on interviews with consultants about landscape photographs for eliciting Takana and Mosetén landscape terms. This methodological approach constrains the inferences that can be made and poses limitations on the generalisability of the results. Conducting field walks with Takana and Mosetén speaking consultants would potentially have resulted in a more complete documentation of landscape terms for these languages that is needed for an analysis that goes beyond the ethnophysiography descriptive model (Turk, Mark, and Stea 2011). Furthermore, linguistic expert knowledge on these languages would be essential to assess to what extent differences observed in this study can be explained by differences in languages or how much is variance is a result of differences in occupations and culturally specific ways of conceptualising the environment.
Most of the elicited Takana and Mosetén landscape terms had not been documented in existing dictionaries (OIM 2011; CIPTA 2011; Ottaviano and Ottaviano 1989) or other documentations of cultural ecological knowledge for these indigenous groups (CIPTA 2010; CRTM 2010). Exceptions were plant names documented in ethnobotanical work with the Takana (Bourdy et al. 2000; DeWalt et al. 1999) and in a study about Tsimanés' vegetation classification (Riu-Bosoms et al. 2014), which is a group related to the Mosetén.

9.4.1 Comparing folk categorisations in Spanish, Takana and Mosetén with other studies

Comparing the findings of this study with previous ethnoecological work, the number of elicited terms for vegetation-based units (the only etically defined category for which comparative data was available) fell well into the range of vegetation terms in folk landscape categorisations of other Amazonian groups (Tab. 17).

Tab. 17 Number of identified landscape units based on vegetation of different groups in the Amazon

Group	Identified landscape vegetation units	Reference
Baniwa	90 'vegetation types'	(Abraão et al. 2010)
Kayapó	26 'folk ecozones'	(Posey 1985)
Matsés	47 'rainforest habitats' (of total 178)	(Fleck and Harder 2000)
Matsigenka	69 'habitats' (of total 115)	(Shepard Jr. et al. 2001)
Mosetén	56 vegetation units (of 189 folk landscape categories)	this study
Spanish-speaking Takana	60 vegetation units (of 156 folk landscape categories)	this study
Takana	66 vegetation units (of 181 folk landscape categories)	this study
Tsimane'	88 'ecotopic patches'	(Riu-Bosoms et al. 2014)

However, comparing the absolute number of terms across studies is difficult, because the methodologies between these studies as well as the definitions of what 'counts' as a category differ considerably. Qualitatively, the categorisations of different Amazonian groups exhibit some similarities. For example, palm species (*Arecaceae* ssp.) seem to be especially important as indicator species and for local use (Fleck and Harder 2000; Shepard Jr. et al. 2001, this study). Furthermore, fallow fields are important features of the landscape for many groups, who distinguish different stages of fallow fields and other patches with gradations of human influence (Posey 1985, this study), especially because of the importance of land use and informal land tenure associated with these fallow fields (this study).

The number of terms for folk vegetation units in Takana and Mosetén, as well as other Amazonian languages might reflect knowledge about overall biodiversity of these groups. However, if the number of terms was an indication of the overall diversity in the bio-physical environment, significantly lower numbers of terms would be expected for vegetation vocabularies for groups living, for example, in boreal landscapes. This hypothesis is not supported by existing ethnoecological literature indicating a high diversification also for less species-rich environments (Aporta 2010; Johnson 2011).

Apart from merely reflecting the diversity of the bio-physical environment, folk landscape classifications may also hold adaptive value. In the current study, many of the documented folk landscape units are areas in the landscape with concentrations of plant species with high economic value for local groups. Such patches have been termed 'resource islands' (Posey 1985). The Takana vegetation unit *madhata judhe*, for instance, is an important 'resource island' in the rainforest, as people visit these areas to collect palm leaves for roof thatching or the landscape type *yuruma wana judhe* is a place for extracting tree parts for medicinal use. In contrast, 'avoidance islands' for the Takanas are areas

with dense and thorny vegetation such as *junu judhe* as a place characterised by dense liana growth, and areas associated with malevolent spirits such as *bai pacha judhe* (oxbow lake). In general, the concept of resource and avoidance islands is closely linked to utilitarian considerations of folk categorisations (Hunn 1982), and allows for a better understanding of how local people assess landscape and its patterning into a mosaic of potentially useful or dangerous places.

9.4.2 Influence of language and culture on folk categorisation

The results showed variations in landscape categorisations in the three languages Spanish, Takana and Mosetén, which speaks to the influence of culture and language on categorisation. Some of the commonalities observed in these three languages of *what* features were lexically encoded suggests that the bio-physical environment does provide a common basis from which different languages carve out geographic features (Stedman 2003), but that this process is non-deterministic, as it is mediated through the different languages and specific cultural contexts. In Takana, the place maker *judhe* was added to a root term such as the plant name *bue* (*charo* plant in Spanish, *Gynerium sagittatum*) to coin the generic vegetation term *bue judhe* for an area of *charo* plants. In Mosetén, the nominaliser *–dyei'* was added to a root term, such as *shiri* (*charo* plant), which then resulted in the Mosetén vegetation term *shiridye'* for an area of *charo* plants. Adding such a place-marker as a suffix to root terms (often plant names) seems to be a strategy for coining landscape terms in other Amazonian languages as well. In the Baniwa language, for example, the suffixes *–lima* or *–rima* are added to plant names to coin generic vegetation terms, such as *wiritilima* from the plant *wiritaa* (Abraão et al. 2010). Whether this strategy is attributable to a linguistic relatedness between Takana and Baniwa (Mosetén is a language isolate), would need to be answered through linguistic analyses that are beyond the scope of this thesis.

Investigating indigenous landscape terms also improves our understanding of the landscape vocabulary in the Spanish *Beniano* dialect. For example, some Takana landscape terms were adopted as loanwords into local Spanish spoken in the study area. Less obvious, but equally important, are borrowed concepts from Takana that are not lexically expressed. For instance, the distinction between *montañas* and *cerros* is different from the standard Spanish understanding of these terms based on size, and might stem from the Takana conceptualisation of topographic features, in which forested and nonforested convex landforms are distinguished.

For elements of the landscape where there were no existing indigenous terms, new terms have been coined with Spanish loanwords transferred into the indigenous landscape vocabulary. For example, the Takana term *arus'u* (rice) that is the root for a Takana landscape term (*arus'u judhe*, rice field) is a loanword from the Spanish *arroz*, a crop that the Spanish colonisers introduced to Latin America. In Mosetén, the term *arrosh* (rice) is a similar case of lexical borrowing. This is a commonly documented process, as lexical borrowings often follow cultural adaptations (Haspelmath 2009).

Although both indigenous languages had a differentiated vocabulary for referring to topographic features, the roots of topographic features in the local Spanish dialect were never indigenous loanwords. Thus, loanwords from Spanish were not only adopted where there was a lexical gap in the indigenous languages, but also in cases where indigenous terms already existed. Why some lexical borrowings take place, and others not, is a topic investigated in detail in linguistics (Haspelmath 2009; Myers-Scotton 2010).

9.4.3 Semantics of folk landscape categories

This thesis highlighted how some landscape categories refer to underlying referents saturated with meanings. For instance, for

both Takana and Mosetén people, the rainforest and mineral salt licks are considered important dwelling places of mythological beings. Such cultural meanings are important aspects of landscape, and have tangible effects on land use, because they shape people's interactions with their environment. For instance, traditionally, saltlicks are important areas for hunters and associated with several cultural taboos. The connection of landscape with the spiritual realm is common for many indigenous peoples. In the Amazon, different studies documented cultural and spiritual meanings of landscape. For example, the Tsimané associate the presence of spirits (*a'mo'*) in each landscape type they identified (Riu-Bosoms et al. 2014), and the Baniwa in Brazil recognised different landscape types and sites with cultural associations and mythological underpinnings (Abraão et al. 2010). The Maijuna in the Peruvian Amazon ascribed high spiritual importance to *mañaco taco*, a forest type with little or no understory growth, which they attribute to invisible malevolent spirits (Gilmore, Ríos Ochoa, and Ríos Flores 2010). Outside the Amazon, landscapes have spiritual meaning for local people, for instance, for the Quechua speaking people in the Bolivian Andes, the landscape is saturated with meaning, as an elder stated:

> '*Pachamama* is everywhere, (..), in the gulches, in the rivers, from the Jatun Mayu river to the protecting mountains (…).'
>
> (Quechua consultant cited in Boillat et al. 2013, p.668)

Often, the spiritual significance of a place is inseparable from the bio-physical reality. For example in Australia, the Yindjibarndi always associate a *yinda* (pool of water) with a *warlu* spirit (Mark & Turk 2003). The Diné (Navajo) in North America do not distinguish between animate and inanimate objects, as many features of the landscape are considered to be male or female, for example with various rock formations believed to be the petrified bodies of spiritual beings from origin stories (Turk, Mark, and Stea

2011). Cultural uses and spiritual meanings are thus important aspects for many communities, and also shape the interactions of people with their environment, which underscores the importance of taking into account such cultural considerations on maps and in GIS that are used for landscape management (Berkes 2008; Berkes, Colding, and Folke 2000; Ens et al. 2012).

9.5 From Space to Place: representing folk landscape categories on maps and in GIS

- *RQ5: How can we better represent local notions of landscape in a computational environment?*

9.5.1 What was represented on sketch maps (and what not)

Some features represented on sketch maps had not been documented through ethnographic methods of field walks and interviews on photographs as part of the landscape vocabulary. Examples of features that were mapped, but not contained in the vocabulary were, for example, animals (e.g. cow, pig, chicken, duck, and fish), people, and anthropogenic elements (e.g. trails, pathways, buildings, football courts). These anthropogenic elements resembled lists elicited in category norm studies that used the elicitation phrase of 'something that could be portrayed on a map' (Mark, Smith, and Tversky 1999; Smith and Mark 2001) much more than the elicited folk landscape categories did compared to category norm studies using elicitation phrases containing 'geographic features'.

Comparing the number of features represented on the sketch maps, the documented landscape vocabulary contained more entries and, the combinations of interviews based on photographs about the uses of these landscape units was a much richer source of information on geographic categories than the sketch maps. The difference in the number of landscape terms used in

the vocabulary and those documented as map features may have a range of reasons. Firstly, a sketch mapping exercise is comparable to a memory recall task in free listing. Consultants may have only mapped instances of features they recalled early during the mapping exercise, such as instances of rivers, trails, or houses. Categories that appeared early in free list tasks were often more basic and shared across participants, while more location specific categories were commonly listed later (Wartmann et al. 2015). Secondly, consultants may have been constrained in how to graphically represent geographic features, as mapping is directly related to consultants' drawing abilities.

The results of this thesis suggest sketch mapping may provide insights into how to localise folk landscape categories and link them more directly to space. However, comparing the information represented on sketch maps with the overall knowledge local people have about their environment, it became clear that consultants only mapped a small portion of their knowledge during the sketch mapping exercise. Using solely sketch maps in a participatory mapping process may therefore fall short of capturing geographic features at fine semantic and spatial granularities that are expressed in natural language, and miss out on culturally important parts of the landscape. In the Madidi area, a participatory mapping project conducted as part of a participatory rural appraisal (Lehm and Chavez 2001), for example, did not document locally important features such as mineral salt licks or other use areas. The management plans that were built on such maps then resulted in conflicts between community members and between different communities about who had access to these areas that had not been identified as important on the hand-drawn maps and in the digitised map in a GIS. Based on this example and the findings of this thesis, I suggest that participatory mapping should be accompanied by other methods that are better suited to capture the rich local knowledge, and the potentially contested semantics of landscapes.

9.5.2 Sketch maps revealed different perspectives

The goal of the sketch mapping exercise was to compare this method with other ethnographic methods such as field walks and interviews, and also to link geographic features to actual space. Therefore, the arrangement of features on the resulting maps and their relation on the map compared to the real-world was not the focus of this work. Rather than framing deviations from standard topographic maps as 'distortions', for the purpose of this thesis I considered sketch maps as consultant's individual understandings of their environment, without judging this understanding against some 'true' representation, which is typically assumed to be the cartographic map. Instead, I focused on analysing the sketch maps for the perspective used as well as for the way in which features were represented in relation to each other. As some consultants were more familiar with standard cartographic maps than others, this may have influenced the perspective they chose for mapping. Consultants familiar with conventional cartographic maps may have learnt spatial relations from such maps (Davies and Uttal 2007) and were trying to reproduce them, while consultants with less exposure to standard maps may not have been influenced in this way. However, level of education did not seem to directly relate to the perspective consultants choose on their map. For instance, some consultants with no or very little formal education chose an aerial view, without being familiar with such perspectives from maps, or from experience of viewing landscapes from above (e.g. by flying in an airplane, or from a vantage point from a mountain) and had somehow learnt to represent their environment from an aerial view through experience, while other consultants with higher map familiarity choose a sideways view. By providing consultants to choose their own perspective, sketch mapping was thus a suitable method to explore local geographic concepts irrespective of the educational background of consultants.

9.5.3 Representing local place-based knowledge in a computational environment

Using participatory observation of GIS use by SERNAP staff in the Madidi protected area and by CIPTA staff in the Takana indigenous territory, I identified current constraints and requirements for a GIS solution for these two organisations. Based on these requirements, I chose to implement a solution using the existing open-source webmapping platform Cartaro with minor adaptations to better suit the identified needs and to enable the integration of other more qualitative sources of information (e.g. pictures and texts). The evaluation showed that while the Cartaro platform provided considerable improvements in usability compared to the experience local users had with ArcGIS, for instance, in how geographic information can easily be added to different base-maps (OSM, GoogleMaps and GoogleEarth), the consultants still expressed difficulties with using the computer interface. Furthermore, there were constraints based on the data formats that were expected for information exchange. Although not a formal legal requirement, consultants stated that governmental agencies in La Paz expect to receive geographic information in the form of shapefiles, which limits the types of information that can be exported from Cartaro. Thus, despite severe issues with software licensing for ArcGIS, both CIPTA and SERNAP Madidi will continue to use ArcGIS because of these requirements, irrespective of the difficulties involved. Another issue with the Cartaro mapping platform was that it required relatively fast internet connection for downloading map tiles, which, despite rapid improvements over the last years still is not always available uninterruptedly in the study area. This issue however can be remedied through caching maps of the study area. Moreover, many people in the study area nowadays use smart-phones with mobile phone plans that include data connection. Therefore, mobile phones could be used as local hot-spots for providing internet connection.

One of the biggest limitations was the difficulty of representing folk landscape categories in a computational environment, in which the data structure for the geographic information consists of a vector model with points, lines, and polygons, which is not specific to Cartaro, but was reported for other participatory GIS (Auld and Kershaw 2005; Gearheard et al. 2011; Wellen and Sieber 2013).

Folk landscape categories documented through ethnographic methods such as participatory mapping represent commonsense geographic concepts that are inherently vague both semantically (e.g. 'what is a forest'), and spatially (e.g. 'where are the boundaries of a forest'). Within GIScience, the importance of vagueness has long been recognised (Burrough and Frank 1996). A range of methods was proposed to deal with vague geographic concepts (Davies et al. 2009; Fisher 2000; Jones et al. 2008; Montello et al. 2003; Straumann and Purves 2011). For instance, different methods were empirically tested, in which participants were asked to delineate crisp regions for the vernacular concept of 'downtown Santa Barbara', and then had to provide judgment calls on regions where they were 100% and 50% confident that downtown was (Montello et al. 2003). In an actual management context, the representation of geographic phenomena such as vague vernacular regions and their spatial delineation are crucial for decision-making. As a consequence, with the example of the Cartaro platform, the person mapping, for example, a mineral salt lick, would then decide where this feature was located, and how it was represented (the currently implemented options being point, line or polygon), which may not be in line with how other people would represent or delineate the same feature.

As a webmapping platform where different users can add and edit data on the web, Cartaro provides the possibility of integrating the views of different users. These users can be anyone with an internet connection (no access restriction), or user roles can be assigned within Cartaro to be limited to a certain user group, for

which each user needs to register. Furthermore, administrators who have the option of reviewing these edits can be assigned in Cartaro. In the small usability study conducted for this thesis, participants appreciated the possibility Cartaro offered of assigning different rights to different users. However, the assignment of rights to view or to edit and view data is imbued with power. Users given the right to edit data influence which information is included (or not included) in the webplatform. This potentially holds the risk of reproducing existing power relations within communities, instead of empowering more users to contribute information. Therefore, if a participatory project was to be implemented past this first trial-stage, I would recommend that capacity building workshops are carried out in villages and at CIPTA meetings so that potentially more users from different socio-economic backgrounds within communities learn how to upload data, and that the selection process for people with rights to contribute and administer data are conducted in a transparent and participatory manner.

Another possibility is to automate the integration of data from very many different users in order to reduce the potential influence of the administrator(s). An adaptation for the open-source platform Cartaro would thus be to implement an automated way of dealing with multiple views of the same geographic feature. For instance, following Montello et al.'s (2003) empirical approach, polygons created by different users for the same features could be automatically combined into a single polygon using efficient algorithms for the union of polygons (e.g. with an adaptation of the 'Intersection Detection' algorithm described by Skiena 1998). This approach would simply compute the union of all polygons of various users, without taking into account which areas were considered as part of the feature in question by how many users. If many users mapped the same feature using point data, kernel density surfaces could provide a method for including notions of vagueness of geographic concepts in actual space (Hollenstein and Purves 2010).

While such technical adaptations may further increase the usability of Cartaro and enable the platform to deal better with commonsense geographic concepts, the political and institutional context still constrained the use of such novel approaches for management, which highlights the importance of taking into account the context in a study area for participatory GIS projects.

9.5.4 Conceptual and formal ontologies of the geographic domain

The results of this thesis showed how a human-readable, conceptual folk ontology of the geographic domain can be built in a bottom-up manner using ethnographic methods with local consultants. Although formal geo-ontologists have criticised the use of ethnographic field-based methods for their 'imprecision' (Brodaric and Gahegan 2001), such conceptual ontologies can serve as a starting point for developing more formal, logical ontologies (Wellen and Sieber 2013). Formal ontologies are considered a requirement for achieving semantic interoperability, that is, the ability of different systems to exchange information and operate effectively together (Kuhn 2005). The formalisation required to arrive from a conceptual to a logical ontology with axioms specified through formal logic entails the resolution of any vagueness in the conceptualisation (Winter 2001). Formalising knowledge in the form of a logical ontology is therefore at odds with vagueness and ambiguity inherent in commonsense geographic concepts, as discussed before (Davies et al. 2009; Fisher 2000; Jones et al. 2008; Montello et al. 2003; Straumann and Purves 2011).

Moreover, previous work with indigenous groups brought to the fore the potential pitfalls involved in the formalisation process. For example, by storing indigenous knowledge in digital form in a GIS, it is removed from its original epistemological framework, becoming decontextualised from its original cultural context and

being transformed in the process (Rundstrom 1995; Johnson 2010a). While the development of more qualitative forms of GIS may remedy some of these challenges (Cope and Elwood 2009; Jung and Elwood 2010; Kwan and Knigge 2006; Leszczynski 2009), qualitative GIS approaches have seldom questioned the core of GIS, that is the actual data structures and geometric primitives that are represented in GIS, and how vagueness inherent in language can be better represented in GIS (Straumann and Purves 2008; Straumann and Purves 2011).

While the results of this thesis provide a first step in the formalisation process, that is, to specify a certain conceptualisation through the use of a folk ontology, further work would be needed to investigate whether specifying a logical ontology based on the presented conceptual ontology would reflect consultant's view of landscape. Only few comparative work exists, for example, a study on formalising folk ontologies of Cree hydrological features in Canada showed that while consultants were able to contribute to the development of a conceptual ontology, their contribution to a logical ontology was minimal, leading to a very non-participatory development of this ontology (Wellen and Sieber 2013). At the end of the Cree folk ontology research project, the formal hydrological ontology was at odds with the Cree's nuanced understandings of their environment. Thus, formal ontologies may not be well suited to represent local understandings of landscape and sense of place. Therefore, despite increasing pressure to formalise local ontologies for improving interoperability, other forms of documenting such knowledge through more ethnographically rich materials such as storytelling and pictures may be better suited to express the varied and rich relationships of people with their lands.

9.6 Re-visiting representations of space and place

The combination of different methodologies for integrating place-based aspects of folk landscape categories into spatial representations on maps and in GIS in this thesis constitutes a step on the way 'from space to place'. Abstractions of space typically found in current GIS do not take into account the varied local meanings and cultural significance of place, which are encapsulated, for instance, in landscape categories and their meanings. Taking into account the socially constructed nature of categories and their relevance in an institutional framework for natural resource management, this thesis highlighted that depending which categorisation is applied, and the underlying assumptions and meanings that relate to these categorisations, influences how people interact with their environment. Categories are thus more than 'just categories', because as a way of structuring knowledge, categories become the basis for representing geographic information, with tangible impacts for people making a living in these landscapes. As Robbins stated:

[.] where competing accounts of what constitutes the categories of landscape exist, the fixing of those categories is an inherently political exercise.

(Robbins 2001, p. 162)

Paying attention to the socio-economic and institutional context in which such categories are embedded is thus important for categorisation research on domains where categories are also units for management. Categorisation research on landscape or geographic categories thus differs in the consequences that such categories have, compared for instance, with studies on categorisations of furniture (Rosch 1975, 1978).
The folk landscape categories presented in this thesis thus provide a potential way of rendering visible local, place-based understandings of landscape which include cultural notions of landscape of non-dominant groups whose views may commonly have been marginalised or overlooked.

No thief, however skilful, can rob one of knowledge,
and that is why knowledge is the best
and safest treasure to acquire.

L. Frank Baum,
The Lost Princess of Oz (1917)

Chapter 10
Conclusions

The overarching research question that guided this thesis was:

- ***How can local landscape categorisations be accessed and represented?***

In the following sections, I highlight the main contributions towards answering this overarching research question, consider the insights and implications from the obtain results of this thesis, before providing an outlook on possible improvements and proposed further work that builds on and extends the current work presented in this thesis.

10.1 Main contributions

Combining ethnographic and GIS approaches to explore landscape conceptualisations of local communities in the Bolivian Amazon, the main contributions of this thesis are to the research areas of landscape ethnoecology, ethnophysiography, and GIScience. Identifying culturally shared landscape units, and taking into account their ecological foundations, local uses and cultural meanings of the real-world underlying referents, this thesis went beyond mere descriptions of landscape terms. Exploring ways in which these folk categories can be linked to spatial representations, on hand-drawn sketch maps and in a computational environment of a webmapping platform, this thesis brought together approaches and considerations informed from fields such as critical and participatory GIS with landscape ethnoecology and ethnophysiography. In the following, I outline some of the thesis' main contributions in more detail.

Understanding the relation of local institutions for natural resource management and landscape categorisations. Based on participatory observation and interviews with local consultants, I investigated the history of institutions for natural resource management in the study area. The analysis showed that different institutions came to co-exist in the study area, which led to institutional pluralism and contestations over whose views are taken into account in management practices. Different institutions based their decision-making on different categorisations of landscape with different underlying meanings and significance, which resulted in conflicts between different actors on whose views were taken into account in management.

Folk landscape categories in the Beniano Spanish dialect. This study documented 157 terms for landscape categories in different etically defined thematic areas such as vegetation, topography and hydrology. By focusing on Spanish as a majority language that is also spoken by Takana indigenous people, this thesis therefore extends existing ethnophysiographic work on indigenous, often endangered languages. Many documented categories in the local Spanish dialect were not contained in standard Spanish dictionaries. By theoretically sampling consultants based on age among other criteria, a wider range of people was interviewed than in previous ethnoecological and ethnophysiographic studies in which typically only elder people were consulted, because they were presumably the most knowledgeable persons in their community. The attention not only to landscape terms, but also to their underlying referents highlighted that

these were in many cases of economic and cultural importance for local people.

Landscape as a categorisation driver. Photograph sorting exercises with consultants provided insights into the hierarchical organisation and possible categorisation drivers, which revealed that topological relations of geographic features in the landscape may influence categorisation.

Folk landscape categorisations in Takana and Mosetén. Using landscape photographs as prompts for interviews with two Takana consultants and two Mosetén consultants, I elicited folk landscape categories for both indigenous languages.
As many of the documented landscape categories in Takana and Mosetén were not contained in existing dictionaries, the results generated in this thesis provide a basis for developing more comprehensive landscape domain vocabularies in the future.

From space to place: linking landscape categories to spatial representations. In order to link terms for landscape units with spatial representations, I conducted sketch mapping exercises to examine which features people choose to represent on sketch maps and how people used scale and perspective in sketch mapping. Based on an analysis of current GIS use and local user needs, I chose to adapt the existing open-source webmapping Cartaro to specific local requirements and evaluated it with users of two different indigenous organisations as well as protected area management. The small usability study showed that Cartaro offered several improvements for local users, for instance, to include qualitative information, but usability remained an issue.

10.2 Insights

In the following, I highlight some of the insights gained from the results of this thesis:

· The results of this study provided further evidence support for the cross-cultural and cross-linguistic variability of geographic categories.

· Ethnographic methods of field walks and interviews with landscape photographs as prompts provided a much richer source of information for folk landscape categories than sketch mapping exercises or participatory GIS.

· The focus on landscape categorisation in a local dialect of a majority language such as Spanish highlighted how folk landscape categories in standard languages can provide insights into place-based knowledge of a speech-community.

· Although consultants in the study area were predominantly monolingual Spanish speakers, they maintained indigenous concepts of landscape as being the dwelling place of people, animals, plants and spirits and notions of sacred places, including culturally agreed norms and rules of behavior considered adequate for such places.

· The meanings and cultural norms of landscape categories seemed to be culturally shared, but may not be apparent to people outside the local speech-community, such as park management staff.

· There was a strong link between the categories used for landscape units (and their semantics) with how these landscape units were managed.

· Because instances of folk categories were not represented on maps or in planning documents, they were commonly overlooked in management decisions are being taken in the local SERNAP offices. Local indigenous organisations also did not use these categories, but relied on mapping features that complied with standard maps commonly used by governmental bodies. Thus, for making visible local landscape categories that link local uses with the actual landscape, folk categories should be used as a basis for producing maps or GIS.

· Considering the social constructedness of landscape categories and the institutional context in which they were embedded helped to situate landscape categorisations in the context of natural resource management.

· Relatively few folk landscape categories were represented on sketch maps and in GIS. Participatory mapping exercises and PGIS approaches should therefore first elaborate a folk ontology or folksonomy to answer the question: what is there (of local importance) to be mapped? before spatially representing these features.

· The anthropogenic features represented on sketch maps were more comparable to reported results for category norm studies eliciting features represented on a map than the elicited folk landscape categories.

· The adaption of an existing open-source webmapping platform for two local organisations provided an option for user-friendly integration of geographic information with pictures and texts.

· The evaluation of this webmapping platform showed that usability remains a challenge, and that the institutional and political context severely constrained the adoption of alternatives to existing off-the-shelf GIS software.

10.3 Outlook[4]

In the following, I first describe how this case study with Spanish, Takana and Mosetén speakers along the Beni River in Bolivia could be extended both geographically and thematically. Furthermore, based on the research conducted during my PhD both in Bolivia and in Switzerland, I identify promising new research areas and introduce an idea for a further research project, which would build on and extend the work presented in this thesis.

10.3.1 Extending the thematic and geographic scope of the current study

The following paragraphs present different ways in which the current study could be further extended both thematically and geographically.

Linguistic aspects. This thesis investigated *what* features of the landscape were lexicalised in the Spanish Beniano dialect, Takana and Mosetén. Another question to investigate is *how* they were encoded in language. As the focus in this thesis was on the identification and description of nouns for folk landscape categories, and despite the identification of three movement verbs relating to landscape in the Spanish Beniano dialect, aspects of the lexicon such as verbs or adverbs were not analysed. In order to more comprehensively study the cognitive representations of the domain of landscape, both the grammatical elements and the lexical specifications would need to be considered (Talmy 2003). Such questions are typically investigated by linguists who choose landscape as a domain to study phenomena of potential interest for general linguistic theories. In order to conduct such linguistic

[4] Ideas described in § 10.3.2 have been described in a proposal to 'cogito foundation' jointly developed with Prof. Dr. Ross Purves.

work in future research, the detailed grammars of Takana (Guillaume 2013) and Mosetén (Sakel 2004) would need to be considered to study the specificity of the grammaticalisation and lexicalisation of landscape compared to other domains in a given language. However, a grammar and lexicon of the Beniano dialect in Spanish are not available. Furthermore, in-depth linguistic analyses would also require the compilation of recordings of direct speech about landscape by native speakers (e.g. Mihas 2015; Rybka 2014). In analysing such data, verb forms would be a particularly interesting aspect, as verbs provide insights into linguistically encoded relationships between people and landscape features, and between different landscape features. Such relationships may be particular to a language. For instance, a study on the Cree language in Canada showed that the Cree specifically used the verb *mischaakuhtin* to denote the action of a large flowing water body traversing a wetland (Wellen and Sieber 2013). The study of verbs relating to landscape features may thus reveal how a certain language constructs mereotopological relations (Smith 1996) as part of the local landscape conceptualisation.

Variation in landscape terminology. The results of this thesis highlighted how local terminology for landscape features in the Spanish Beniano dialect varied from the vocabulary contained in dictionaries of standard Spanish, such as the 'diccionario de la lengua española' (DRAE 2014). An aspect to explore more deeply would be the variation in landscape terminology and associated landscape ethnoecological knowledge within a group of speakers of the same dialect. For instance, a study with the Tsimané in the Bolivian lowland demonstrated that people from different villages in a geographically limited area exhibited considerable differences in ethnoecological knowledge (Reyes-García et al. 2005). In this thesis, the agreement on the terms used to describe landscape photographs was high among Spanish speaking consultants, but the Spanish Beniano dialect is spoken in a much larger region than the study area. Therefore, I can make no inferences on the potential variation in landscape terminology in Beniano between different regions. Interesting insights may be gained by exploring landscape conceptualisations at different locations within the same language and similar cultural contexts. For example, a follow-up study could be conducted in the settlement of Santa Ana de Yucuma in the Bolivian lowland. There, the landscape consists of riverine habitats and open grasslands, which may provide insights into the influence of the bio-physical landscape and cultural preoccupations on geographic categories in the *Beniano* Spanish dialect. To enable direct comparisons, interviews could be conducted using the same set of photographs as prompts as in this study and extending this set with photographs from the local setting in Santa Ana de Yucuma.

For the Mosetén and Takana language, I mainly used data from interviews with 2 consultants for each language, which limits the inferences about variation that can be made. Future research should thus also consider differences between speakers in the same site based on gender, age groups and occupation.

10.3.2 Combining ethnographic approaches with user-generated content for landscape descriptions

One of the limitations to conducting ethnographic research is the considerable effort required for field work, and the limited spatial and temporal extent of the elicited information. In GIScience, there has been a recent interest to apply geographic information retrieval techniques to automatically extract landscape descriptions from unstructured text (Derungs and Purves 2013; Purves and Derungs 2015) and user-generated content from the web (Hollenstein and Purves 2010; Huldi 2015). While user-generated content and crowd-sourced data offer rich grounds for research because of the potentially large volumes of data available, this comes at the prize of much less control about the context of data

creation, and there is only little information available about individual contributors. Automated methods with large text corpora offer promising avenues for generating landscape descriptions of very many users in a fairly short amount of time. However, these methods differ considerably in the scope and depth of analysis compared with more ethnographic approaches as applied in this thesis, which are commonly used in research fields of linguistics, landscape ethnoecology and ethnophysiography, where the focus was on small populations living in rural environments, often speaking endangered languages.

For further research, I suggest that ethnographic and computational approaches may be productively applied to study culturally recognised landscape categories in the global north, exploring both the rich semantics of landscape categories through ethnographic methods and achieving larger temporal and spatial coverage through the inclusion of user-generated content. In the next section I sketch out ideas for a research project in Switzerland that would combine ethnographic work and user-generated content for investigating landscape categorisations and landscape descriptions.

Firstly, using outdoor free listings tasks (c.f. Wartmann et al. 2015) with participants recruited at different sites in Switzerland, folk landscape categories in Swiss German would be elicited. Secondly, passively crowd-sourced data from social media and user-generated content (e.g. tag descriptions from georeferenced Flickr images or tags that co-occur with toponyms such as ‘Lake Zurich’) could be used to explore terms for describing locations and properties of places (Purves et al. 2011). Using this approach much large sample sizes can be achieved than using ethnographic methods. Exploring user generated content thus offers the possibility of comparing the variation and richness of language used to describe places with free listing data collected at the sites the passively crowd-sourced data refer to.

Thirdly, an active crowd-sourcing approach could use methods successfully applied in previous research in a 'Citizen Science' project on landscape (Edwardes and Purves 2008). Citizen Science projects aim at engaging the public by including citizens in a range of capacities from collecting to analysing data, and defining research questions (Haklay 2013). For such a proposed project, from a research perspective, Citizen Science has the potential of combining the advantages of user-generated content of potentially large spatial and temporal coverage with the benefits of ethnographic methods that typically entail more control over the context and are specifically targeted at a research question. Furthermore, from a communication perspective, including citizens in science enables an engagement with the public typically not achieved (or aimed for) in research projects. However, as landscape and places are part of everyday experience of many people, engaging with interested citizens in landscape research may not only provide viewpoints from those held by scientists and domain experts, but also foster new research ideas.

When in doubt, go to the library

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Harry Potter and the Chamber of Secrets

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de tan impenetrable.
Andas. No dejan huellas tus pies.
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el aliento sobre tu cabeza.
Un pájaro no sabe que estás allí,
y lanza su silbido largo
al otro lado del paisaje.
El mundo cambia de color:
es como el eco del mundo.
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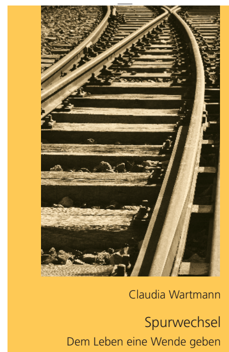

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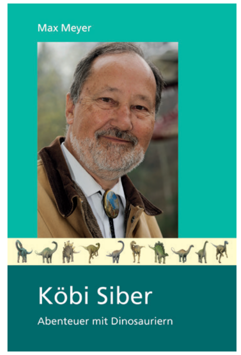

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